APPLIED MECHANICS Reviews

A CRITICAL REVIEW OF THE WORLD LITERATURE IN APPLIED MECHANICS AND RELATED ENGINEERING SCIENCE

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GENERAL

Physics, General 513
Analytical Methods in Applied Mechanics 513
Computing Methods and Computers 514
Analogies 515
Kinematics, Rigid Dyamics and Oscillations 515
Instrumentation and Automatic Control 517

MECHANICS OF SOLIDS

Elasticity 520
Viscoelasticity 523
Plasticity 524
Rods, Beams and Strings 525
Plates, Shells and Membranes 525
Buckling 528
Vibrations of Solids 528
Wave Motion and Impact in Solids 532
Soil Mechanics: Fundamental 534
Soil Mechanics: Applied 535
Processing of Metals and Other Materials 535
Fracture (Including Fatigue) 536
Experimental Stress Analysis 537
Properties of Engineering Materials 538
Structures: Simple 539
Structures: Composite 540
Machine Elements and Machine Design 541
Fastening and Joining Methods 541

MECHANICS OF FLUIDS

Rheology 541
Hydraulics 541
Incompressible Flow 545
Compressible Flow (Continuum and Noncontinuum Flow) 546
Boundary Layer 550
Turbulence 551
Aerodynamics 551
Fluid Machinery 553
Flow and Flight Test Techniques and Measurements 555

HEAT

Thermodynamics 558
Heat and Mass Transfer 559
Combustion 563
Prime Movers and Propulsion Devices 565

COMBINED FIELDS AND MISCELLANEOUS

Magneto-fluid-dynamics 566
Aeroelasticity 567
Aeronautics 567
Astronautics 567
Ballistics, Explosions 569
Acoustics 569
Micromeritics 571
Porous Media 573
Geophysics, Hydrology, Oceanography, Meteorology 577
Naval Architecture and Marine Engineering 583
Friction, Lubrication and Wear 584

Books Received, 585

Computational Problems in Exploration Geophysics, Raoul Vajk, 511

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APPLIED MECHANICS REVIEWS

VOL. 12, NO. 8 MARTIN GOLAND *Editor* AUGUST 1959

COMPUTATIONAL PROBLEMS IN EXPLORATION GEOPHYSICS

RAOUL VAJK

Producing Coordination Department, Standard Oil Company (N. J.), New York

THE most popular branches of exploration geophysics are the magnetic, gravitational and seismic methods. The magnetic and gravity surveys measure and map the magnetic and gravity fields of the earth. As both magnetic and gravitational fields may be influenced by the lithology and geology of the earth's crust, lithological and geological conclusions can be made from the areal variations of these fields.

The seismic method uses elastic waves (sound waves) artificially generated in the ground or in the water (sea, lake, swamp), and investigates the propagation of these waves in the various geological strata, their reflections from, and refraction at, the contact surfaces between two layers with different physical characteristics.

The aim of the above-described geophysical investigations is to learn something about the subsurface geology. Lithological changes and geological features disturb the homogeneity of the earth's crust, thus causing variations, i. e., anomalies, in the gravity and magnetic fields of the earth and in the uniform, rectilinear propagation of the elastic waves. The problem is to draw conclusions from the measured gravity and magnetic anomalies and from the recorded arrivals of the seismic impulses (originating from an artifical source) as to the subsurface geological features and lithological changes.

The gravity and magnetic fields are potential fields and their anomalies to be investigated for geological purposes are changes in the respective forces in space. On the other hand, the seismic data (recorded on the seismograms) are time series repeesenting the changes in time of the position, velocity, or acceleration of a vibrating point usually at the surface of the earth.

The most frequent computations in geophysical exploration are as follows:

A. Corrections

1. *Magnetic data*: Simple addition or subtraction of the diurnal variations of the magnetic intensity data from the observed magnetic values.

2. *Gravity data*: (a) Positional corrections, such as latitude and elevation; (b) physical corrections, such as the gravity effect of the topographical features.

3. *Seismic data*: (a) Static corrections, correcting the arrival time of seismic impulses for the elevation of the geophones (seismic detectors) and for the effect of the low velocity surface layer; (b) dynamic corrections, correcting the arrival times for changes of seismic velocity in rocks, and for the time differences of the arrival of seismic waves at the individual geophones due to the horizontal distances between the geophones.

B. Interpretational Problems

1. *Gravity and magnetic methods*: (a) The gravity (magnetic) effects of various assumed geological structures are computed. These computed gravity and magnetic effects of the assumed structures are then compared with the observed values and the assumptions are changed until the computed effects are in agreement with observed data. (b) In certain phases of the interpretation, the second vertical derivative of the gravity (or magnetic) field is required. This is done by a surface integration method, or by computing differences of weighted averages of discrete gravity (or magnetic) values. (c) In an attempt to separate the gravity effect of deep-seated geological structures (called regional gravity effect) from the gravity effect of the relatively shallow structures (residual gravity), it is customary to compute a polynomial which approximates the observed gravity values. This polynomial is then accepted as the regional gravity.

2. *Seismic methods*: The seismic problems are mainly related to the determination of the paths of the seismic waves in layered media where the individual layers are characterized by different seismic velocities. For instance, the minimum path of the seismic waves between two points, each in a different medium separated by a plane, has to be determined. Or, the path of reflected and refracted elastic waves penetrating several geological strata, each with a different seismic velocity, has to be constructed, etc.

Computation of the corrections can be handled, in most cases, by desk calculators. However, and especially if a great number (several thousands) of observations must be processed, some gravity corrections (elevation and topographic corrections) are voluminous enough to warrant the use of the electrical computers. Computations related to gravity and magnetic interpretations can be handled by desk calculators and graticules only with difficulty. Since gravity and magnetic interpretations are potential field interpretations, they are inherently ambiguous. This means that there exists an infinite number of geological features all of which have practically the same gravity and/or magnetic effects (that is, within the accuracy of the observations). The time needed for arriving at a single possible solution by desk calculators or graticules is long enough to prohibit the computation of more than one or two solutions. The speed of the electrical computer is needed to work out numerous possible solutions from which the geologically most probable can be selected and accepted.

Theoretically there is only one solution for the second vertical derivative of a function. However, the practical computation of the second vertical derivative of the gravitational or magnetic field is an approximation based on a finite number of observed (and/or interpolated) data at points determined by a grid placed over the gravity or magnetic map. The distance between the grid points may be varied arbitrarily, and the approximative value of the second vertical derivative of a gravity

or magnetic field is the function of the distance between the grid points and of the relative position of the grid to the gravity or magnetic map. It is customary to use several different grids when computing the approximate second derivative values for the same set of gravity or magnetic data.

Without going into further details, we may state here that carrying out the above computations for an area of 1000 square miles and with a single grid involves about 20,000 separate lengthy calculations. Such an analysis can be made only by the use of an electrical computer.

Other computations related to the interpretation of potential field data are similarly complex and require the use of modern high-speed computers.

The goal of the analysis of seismograms is to determine the depths, dips, and shapes of the various reflecting and refracting rock strata, that is, to determine the particulars of subsurface geological structures.

The above-listed problems in connection with seismic interpretation are more or less involved and can, again, be economically solved only by modern electrical, or specially designed, analog computers.

DIGITAL OR ANALOG COMPUTER

The question may now be raised, which of the two types of computers should be used in solving geophysical problems?

As mentioned before, the digital computers are, in general, more popular than the analog electrical computers. One possible reason for this is the ability of the digital computers to produce an answer accurate to the last decimal. Such accurate answers are needed in bookkeeping, in payroll computations, in inventories, etc. The analog computers, in general, are not capable of such accuracy, although their accuracy is better than sufficient for most engineering and practical physical and geophysical problems. The geophysical problems mentioned can all be solved by analog computers. As the problems become more and more complex, the programming, that is, the writing of instructions for the computer on punch cards or in any other form, also becomes more and more involved and more time-consuming. It takes considerably more time to work out the program and instructions for the digital computers than the time needed by the computers to complete the actual computation. In case of complicated computations, the analog computers may have the advantage of requiring considerably fewer instructions than the digital computers. We should remember that the digital computer is a "simpleton."

Besides the electrical analog computers there are other types of analog computers which are built to accomplish certain special tasks and which can usually be applied to that limited field only. However, in their field they solve the problem in an ingeniously simple way, within a short time, and often their construction is simple and inexpensive. The well-known and widely-used slide rule is a good example for this type of analog computers. A great variation of computations (addition and subtraction excluded) can be made with the slide rule, but with limited accuracy.

SPECIAL ANALOG COMPUTERS IN EXPLORATION GEOPHYSICS

A few analog computers designed specifically for certain geophysical computations are described below:

1. *An analog computer for the synthesis of reflection seismograms from well data.*

It was mentioned earlier that in the seismic method conclusions are drawn from the seismograms as to the depths, dips and shape of the subsurface rock strata. For the correct geological interpretation of seismograms it is very helpful to learn what kind of seismogram is the result of seismic impulses reflected from a known series of rock strata. By a seismic velocity survey made in a borehole, the seismic velocities of the individual rock strata penetrated by the hole can be determined, and their acoustic impedances can be estimated. From these data the relative seismic energies reflected by the individual rock strata, and their arrival time to the sesimograph at the surface, can be computed. This computation in itself is rather lengthy and the construction of the seismogram from the computed data is cumbersome.

The so-called *"Seisyn" computer** solves this problem quickly in the following way: The logarithms of the acoustic impedances of the rock strata are plotted against the depth of the strata multiplied by the double seismic velocity. One side of the curve is "blacked-in" and is transferred photographically onto a film. The film is fed into the Seisyn apparatus and is scanned photoelectrically. The apparatus produces an electric pulse on the film, simulating a seismic energy impulse at every change in the amplitude of the acoustic impedance curve. The electric pulses are amplified and summed, and finally recorded by an oscillograph camera.

The Seisyn apparatus is an example of a specialized electrical analog computer as it simulates the seismic waves by electrical pulses, and can be used only for the specific purpose of producing synthetic seismograms from well data.

The *Gravity Anomaly Simulator*** is used to compute the gravity effect of an assumed geological structure. The geological structure is divided into horizontal layers, and a mask is made for each layer by cutting a hole in a sheet of black paper corresponding to the contour of the particular layer. This mask is placed on a translucent horizontal plate uniformly illuminated from below. The light passing through the mask is measured by a light meter of small horizontal dimensions. The measured light intensity is proportional to the gravity effect of the horizontal layer of the geological structure represented by the mask. The vertical distance of the light meter from the mask must be proportional to the depth of the layer. A light intensity measurement is made for each mask (each layer), adjusting each time the distance of the light meter from the mask to correspond to the depth of the particular layer. The sum of the intensity measurements multiplied by a constant gives the gravity effect of the geological structure.

The gravity anomaly simulator is an analog computer in that it substitutes gravitational force for light intensity.

A *graphical device* for determining minimum travel-time path across a single interface between two layers with different seismic velocities (V_1 and V_2) is shown in Figure 1.

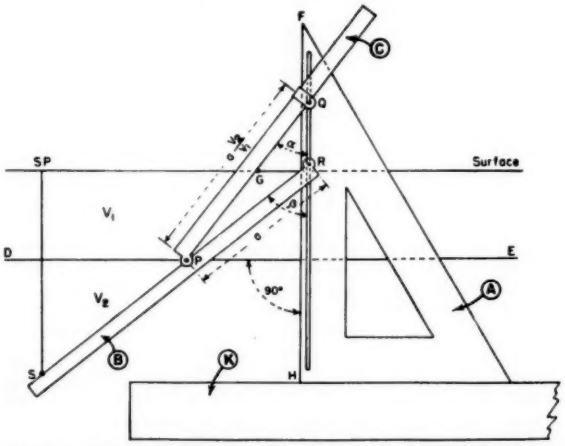

Fig. 1. Graphical device for determining minimum travel time path across single interface

*Developed by the United Geophysical Corp., Pasadena, California.
**Developed by Geophysical Service, Inc., Houston, Texas.

Stick pins at points G and S (the points to be connected by a minimum travel-time path) and place the device on the paper so that the lower edge of C touches the pin at G and the upper edge of B touches the pin at S. The triangle A should rest on a steel ruler K which is parallel to the interface DE. Keeping rulers C and B constantly in touch with the pins at S and G, move the triangle along the steel ruler to the right or left, until you can bring point P on line DE. Then draw the lines PS and PG, which furnish the solution of the problem.

The mathematical proof is simple. It is stated that at any position of the rulers B and C (Figure 1) $\sin\alpha/\sin\beta = V_1/V_2$.

Considering Figure 2,

$$\sin\alpha/\sin\beta = \frac{p/\overline{PQ}}{p/PR} = PR/\overline{PQ}$$

Let be $PR = a$, and $PQ = a(V_2/V_1)$ then

$$\sin\alpha/\sin\beta = a(aV_2/V_1) = V_1/V_2. \qquad \text{Q.E.D.}$$

The above device is an analog computer as it substitutes geometrical relations for the relation of velocities, which are physical quantities.

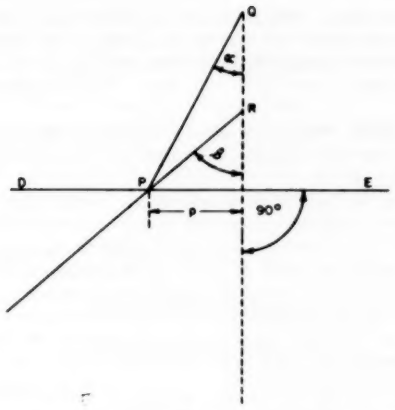

Fig. 2. Geometrical representation of device shown in Figure 1.

In conclusion it may be stated that there are many problems in geophysics which can be solved by analog computers. At the present time electrical analog computers are used only sporadically in exploration geophysics, as the digital computers are for some reason more popular; the use of analog computers in geophysics is mainly restricted to computers devised for special problems. In the writer's opinion, mounting programming problems in connection with the use of digital computers and the ability of the analog computers to furnish solutions in the form of continuous curves will eventually change the trend, and analog computers will occupy the place which they truly deserve in geophysical computations.

REFERENCES

1 Kaufman, S., An analog computer for rapid computation of potential-field data (Publication no. 27, Exploration & Production Technical Division, Shell Oil Co., Houston, Texas), *ISA J.* 8–12, Jan. 1953.

2 Koff, Richard M., Solution by analogy, *Prod. Engng.* **30**, 4, 28–30, Jan. 1959.

3 Geyer, R. A., and Romberg, Frederick, What is a gravity anomaly? *Oil and Gas J.*, 196–200, April 30, 1956.

4 Vajk, Raoul, Devices for the construction of refracted rays, *Geophysics*, **XIX**, 237–241, 1954.

5 Peterson, R. A., Fillipone, W. R., and Coker, F. B., The synthesis of seismograms from well log data, *Geophysics*, **20**, 3, 516–538, July 1955.

Physics, General

Book—3707. Condon, E. U., and Odishaw, H. (edited by), Handbook of physics, New York, McGraw-Hill Book Co., 1958, xxvi + 1460 pp. $25.

One might, at first thought, wonder why a book of this title should be reviewed in this journal—the answer lies in the content and concept of this outstanding volume.

This book is not a handbook in the usual sense of presenting masses of tabular and graphical data, but rather it is an expository volume on the underlying principles of Physical Science and the mathematical techniques useful in the various branches of this science. As such, it is perhaps related to the well-known volume edited by Eshbach, but even here the treatment is much broader and more fundamental. The main sections of the book cover mathematics, mechanics of particles and rigid bodies, mechanics of deformable bodies, electricity and magnetism, heat and thermodynamics, optics, atomic physics, physics of the solid state, and nuclear physics. Each of these sections has been prepared by an authority in the field and is not only clearly written but is on an exceedingly high plane.

As is evident from the above list of contents, the material covers most of the significant areas of Applied Mechanics and Applied Mathematics—to this reviewer, at least, the present volume will serve admirably as a one-volume compendium on Applied Mechanics, as well as Physics, for many years to come.

H. N. Abramson, USA

Analytical Methods in Applied Mechanics

(See also Revs. 3714, 3715, 3716, 3717, 3718, 3719, 3732, 3736, 3738, 3744, 3747, 3793, 3809, 3810, 3812, 3833, 3927, 3932, 4045)

Book—3708. Lambe, C. G., Applied mathematics for engineers and scientists, New York, Macmillan Co., 1959, xii + 518 pp. $8.50.

Specifically the subjects covered in the book are mainly topics in dynamics, statics, strength of materials, and fluid dynamics at the undergraduate and intermediate levels. The last chapter covers Legendre functions, Bessel functions, wave equation, and heat-flow equation. A large number of examples and well-chosen problems supplement each of the thirteen chapters of the book.

E. G. Volterra, USA

3709. Fettis, H. E., On the eigenvalue Latzko's differential equation (in English), *ZAMM* **37**, 9/10, 398-399, Sept./Oct. 1957.

3710. Bowman, C. C., and Hansen, V. E., Simplification of dimensional analysis, *Proc. Amer. Soc. Civ. Engrs.* **85,** EM I, Part I (*J. Engng. Mech. Div.*), Pap. 1898, 7 pp., Jan. 1959.

If the variables in a problem of dimensional analysis are given, a complete set of dimensionless products may be obtained by rou-

tine computations. Authors discuss simplifications of the procedure that result from: (1) Special arrangement of the variables in the dimensional matrix; (2) construction of dimensionless products by inspection. H. L. Langhaar, USA

Book—3711. Volk, W., Applied statistics for engineers, New York, McGraw-Hill Book Co., (Chemical Engineering Series), 1958, xi + 354 pp. $9.50.

Although this book is the outgrowth of a course taught to graduate Chemical Engineering students at the Polytechnic Institute of Brooklyn, it will interest a much wider group of engineers and applied scientists.

The presentation is very clear and is supplemented by well-chosen examples and problems. Reviewer found chapters 4 through 8 of particular interest. In these chapters are presented applications of statistical tests to samples of data from current literature. E. G. Volterra, USA

3712. Mandelbrot, B., A research study in statistics, AFOSR TR 57-97 (ASTIA AD 148 011), 31 pp., 1956-57.

Paper contains a summary of author's estimation-theoretical approach to thermostatistics, distinguishing "observable" and "estimable" physical quantities, and applications of thermodynamical methods in communication theory and in econometrics. Nonphysical thermodynamic systems are classified by the location of the singularities of their generating functions. Author's "Theorie mathematique dela loi de Zipf" on the frequency of words, is briefly sketched. A theory of V. Pareto's law of income distribution is given, based on P. Levy's non-Gaussian stable probability distributions. P. E. Kriezis, Greece

Book—3713. Goldberg, S., Introduction to difference equations, New York, John Wiley & Sons, Inc., 1958, xii + 260 pp. $6.75.

This interesting and well-written volume is intended primarily for students of the social sciences. It is more than a book on how to solve difference equations as much emphasis is given to setting up these equations for economic, psychologic and socialogic models. There are many examples with references to the literature. For instance, examples deal with problems in economic dynamics, learning, income variation, inventory analysis and operations research.

Very little mathematical preparation is supposed and the author skillfully develops needed tools as the narrative unfolds. In four starred sections, analogies between the difference and differential calculus are discussed, and these may be omitted without altering the remainder of the text. This suggests a pedagogical question of interest to all applied workers. Can the difference and differential calculus be taught as a single integrated course?

Mathematically, the book is concerned with the solution of difference equations with constant coefficients. Chapter 1 takes up the Δ and E operators and the problem of summation. First-order difference equations are treated in Chapter 2, and higher-order systems is the subject of Chapter 3. Some selected topics such as stability, characteristic value problems, generating functions and matrix methods form the substance of Chapter 4.

Author's style is lucid and rigorous. There are numerous exercises to aid the reader in understanding the subject.

Y. L. Luke, USA

Computing Methods and Computers

(See also Rev. 4242)

Book—3714. Lukaszewicz, J., and Warmus, M., Numerical and graphical methods [Metody Numeryczne i Graficzne], Vol. I, Warsaw, Panstwowe Wydawnictwo Naukowe, 1956, 429 pp.

Book is intended as auxiliary text for college use and reference for engineers and applied mathematicians. Mainly it fills the gap in Polish mathematical literature on the subject; as such it is of less use for English-speaking student who has similar texts available [J. B. Scarborough, "Numerical mathematical analysis," Oxford University Press, 1955]. Volume I reviewed excludes approximate solutions of differential equations, interpolation of functions of many variables, mechanical cubature, etc., which are to be presented in Volume II. It emphasizes the use of nomograms and slide rule. With Volume II it will cover the scope of reference. Presentation is very lucid and well organized. Knowledge of elementary mathematics, basic analytical geometry, differential and integral calculus is needed to follow the text.

Scope of book is best shown by headings of its ten chapters: (1) Introduction to theory of errors; (2) Introduction to difference calculus; (3) Interpolation (Lagrange, Newton, Gauss, Stirling, Bessel, etc., formulas); (4) Approximation (Monotonic, Power Series, Least Squares, Harmonic Analysis, etc.); (5) Approximate solution of equations and their systems; (6) Solution of systems of linear equations (Krakowians, elimination, etc.); (7) Numerical and graphical methods of differentiation and integration; (8) Scale and function graph papers; (9) Slide rule; (10) Nomograms.

Reviewer believes the text is worthwhile for college students, but not as a reference for engineers without Volume II (to be published). H. Hurwicz, USA

3715. Guest, J., Optimum equi-distant strip formulae in numerical quadrature, *Aero. Res. Lab. Melbourne, Austral., Guided Weapons Note* 7, 16 pp., Aug. 1958.

Formulas for the numerical evaluation of a definite integral have been derived, which contain n (3, 4, 5, 6, 7, 8, 9 and 11, respectively) equally spaced values of the integrand. The first and second one ($n = 3$ and 4) present Simpson's and Newton's well-known rules. Better accuracy can be obtained by using the formulas for higher values of n. J. Buhrman, Holland

3716. Sheldon, J. W., Algebraic approximations for Laplace's equation in the neighborhood of interfaces, *Math. Tables Aids Comput.* **12,** 63, 174-186, July 1958.

Let C_i, $i = 1,2$ be two simple, closed plane curves with continuous curvature. Let C_2 enclose C_1. Let G_1 be the region interior to C_1, and G_2 the region exterior to C_2. Let W be a continuous bounded function of position on C_2. Suppose one desires harmonic functions V_i such that (a) $V_2 = W$ on C_2; (b) V_i is regular and bounded in G_i; (c) $V_1 = V_2$ on C_1 and (d) the normal derivatives of V_1 and V_2 are proportional on C_1. Paper studies construction of V_i using finite difference methods. Problems of this type arise in electrostatics, heat conduction, diffusion, and fluid flow in porous media. In the latter problem, C_1 may be a moving curve.

Y. L. Luke, USA

3717. Conte, S. D., and Dames, R. T., An alternating direction method for solving the biharmonic equation, *Math. Tables Aids Comput.* **12,** 63, 198-205, July 1958.

Authors consider finite difference analogs of a well-known problem for determining deflections of a square plate with appropriate edge conditions. If M is a positive integer, $M = 1/h$ where h is a mesh length, conventional representation is of the point relaxation type and requires solution of an $(M-1)^2$ linear equation system. Technique of present paper involves line relaxation and iterative solution depends on solution of linear equations systems of order $(M-1)$. Convergence of iterative procedure is established and a format for solution is presented. Y. L. Luke, USA

3718. Wasow, W., On the accuracy of implicit difference approximations to the equation of heat flow, *Math. Tables Aids Comput.* **12,** 61, 43-55, Jan. 1958.

Paper considers problem of temperature in a finite rod. Ends of rod are always at zero temperature and an initial temperature distribution along the length of the rod is known. The partial differential equation is represented by a finite difference scheme of implicit type. Paper studies convergence, stability and truncation error of this system. Useful numerical estimates are derived.

Y. L. Luke, USA

3719. Liu, S. W., A numerical method for solving boundary-layer equations, *J. Aero/Space Sci.* **25,** 9, 598–599 (Readers' Forum), Sept. 1958.

A numerical method is described for the solution of ordinary linear differential equations of the third order with known variable coefficients. Such equations often arise in boundary-layer investigations. The method is a combination of Milne's four-point method and the trapezoidal formula. It has been used on high-speed computing machines and its efficiency has been checked in a number of boundary-layer investigations.

E. R. G. Eckert, USA

3720. Zwetz, H., and Ernst, D., Investigation of live steam temperature control with steam generators through an analog computer (in German), *Brennstoff-Warme-Kraft* **10,** 8, 353–361, Aug. 1958.

The discharge temperature from steam superheaters may be regulated by water injection into the saturated steam from the boiler. The response of the discharge temperature to changes in water injection rate is characterized by distance/velocity lag (dead time) and exponential transfer (capacitive) lag, the former being the factor making close temperature control difficult to achieve. By appropriate hook-up of electronic analog computer components, authors have simulated the transfer characteristics of steam superheaters. Dead time was approximated by a series of d c amplifiers with r c input and feedback networks. Another part of the analog computer was used to represent the temperature controller. Sinusoidal and repetitive step disturbances were introduced and the output voltages were observed on an oscilloscope. A number of different control schemes and controller actions were thus explored and the ranges of optimum control established.

A. W. Gessner, USA

Analogies

(See also Revs. 3720, 3967)

3721. Ryder, F. L., Applications of electrical analogs of static structures, *Proc. Amer. Soc. Civ. Engrs.* **85,** EM I, Part I (*J. Engng. Mech. Div.*), Pap. 1895, 26 pp., Jan. 1959.

An extension of author's previous paper [AMR **7** (1954), Rev. 2783] treats three-dimensional rigid frames and nonlinear problems. Partitioning of large structures and thermal load problems are also discussed. Reported experimental results indicate that errors may be limited to the order of 1%.

M. L. Pei, USA

3722. Spotts, M. F., Support-spring analogy simplifies solution of indeterminate shaft and bearing loads, *Machine Design* **31,** 1, 133–136, Jan. 1959.

A method for solving for bearing reactions and bending moments for indeterminate shaft-bearing systems is presented. This method takes into account the flexibility of bearing supports.

W. J. Anderson, USA

3723. Hacques, G., Calculation of the effect of incidence on an annular lifting surface by the method of rheoelectric analogy (in French), *C. R. Acad. Sci. Paris* **245,** 26, 2476–2479, Dec. 1957.

A technique is described in which the problem of the lifting ring wing is treated by means of a deep water tank. The proper boundary conditions are satisfied electrically on the wing (represented by a thin circular cylinder) and on the wake (represented by an extension of the cylinder in the axial direction). Author takes advantage of bilateral symmetry and treats only one quadrant of flow field. The resulting variation of lift curve slope with aspect ratio agrees very well with Weissinger for the range of aspect ratios investigated. The pressure distribution is also obtained, and author suggests treating general (warped) ring wings by applying reverse-flow theorems.

A. H. Sacks, USA

Kinematics, Rigid Dynamics and Oscillations

(See also Revs. 3708, 4166, 4186)

3724. Brearley, M. N., and Bolt, B. A., The dynamics of a bowl, *Quart. J. Mech. Appl. Math.* **11,** 3, 351–363, Aug. 1958.

A mathematical model is set up for dynamical behavior of a bowl which rolls on a deformable plane surface. Approximate solutions of equations of motion are obtained which describe bowl's behavior under normal playing conditions. These give the equation of the path and show that the angle of deflection from a straight line is independent of velocity of projection provided the bowling green conditions remain unchanged. Intrinsic equation of the bowl path is of the form $s \propto 1 - e^{-p\psi}$ (parameter p and the constant of proportionality depend on the type of bowl and the green conditions). The results are compared with observations on bowling greens and test-tables.

From authors' summary by R. Nardini, Italy

3725. Bottema, O., First integrals of dynamical systems (in English), *ZAMP* **8,** 5, 418–420, Sept. 1957.

It is shown that if one or more of the Lagrangian equations of motion of a dynamical system are replaced by first integrals, the resulting solutions are not necessarily solutions of the omitted Lagrangian equations. This is illustrated by an example of a double pendulum, where application of the principles of conservation of energy and of moment of momentum would lead to a wider class of solutions than follows from the equations of motion. The reason is that first integrals are consequences of the equations of motion, but the reverse is not true.

A. I. van de Vooren, Holland

3726. Tsitovich, P. A., Motion of a particle of variable mass (in Russian), *Dokladi Akad. Nauk UzSSR* no. 2, 15–17, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12381.

The motion of a particle of variable mass is investigated on the assumption that the absolute velocity of the changing particles is equal to zero. For this case, when a force function is present, a first integral is found which differs from the energy integral by the fact that instead of mass being represented in it, the square of the mass of the particle is substituted.

M. I. Efimov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3727. Boldinskii, G. I., and Zel'tin, A. I., Coriolis' theorem (in Russian), Collection of works on scientific investigations, Tashkentsk-tekstil'n. In-ta no. 3, 135-139, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12384.

It is proposed to take as the transition and relative accelerations of a point the full derivatives by time from the transition and relative velocities respectively (the authors call them the full transition and full relative accelerations of the point). In such a case the absolute acceleration of the point would consist of the sum of two accelerations—the full relative and the full transition

acceleration—each containing half of Coriolis' acceleration. It should be noted that the proposed method for determining the absolute acceleration, while not exactly faulty, is more complicated than the method generally adopted, in that the descriptions full relative and full transferable acceleration have no simple kinematic meaning.

D. R. Merkin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3728. Mikhalovskii, V. A., Theory of motion of a particle along a rotating-oscillating surface (in Russian), *Nauch. Tr. Ukr. S.-Kh. Akad.* **8,** 387-392, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12379.

Differential equations are derived for the motion of a particle on a surface carrying out an oscillating circular motion round an immovable axis. Assuming no breakaway of the particle, author merges the problem with the integration of a linear equation of the second order with periodic coefficients. The solution of the given equation is sought in the form of a series in powers of time t.

V. S. Novoselov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3729. Novoselov, V. S., Some problems of the mechanics of variable masses taking into account the internal movement of the particles, Part I (in Russian), Vestnik Leningr. In-ta no. 19, 100-113, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11216.

A generalization is given for Meshcherskii's equation for the case of "the relative movement of particles at a point in a variable mass." The adopted definition is: "By the material point of the variable mass we understand a variable system of particles of a constant mass, the dimensions of which we disregard and consider it to be concentrated during the whole of the time of movement at any geometrical point of some auxiliary system of coordinates." When deducing the equations it is assumed that the velocities of some of the particles at the point in question, the sum of whose mass is inclined towards zero when $\Delta t \to 0$, change not only continuously but also in jumps. Two examples for the application of the equations are investigated: a vertically ascending motion of a rocket and the motion of a jet aircraft in a horizontal plane. The principles are deduced for the change of the main vector of the quality of motion and the kinetic moment of the system of points of the variable masses and the solid body of the variable mass. The forces and moments are determined which have to be added to the externally applied forces and moments when recording these principles. By the expression "solid body of the variable mass" is understood a compact system of material points of variable masses, the distance between them remaining constant. Examples are examined of the application of the deduced equations. The possibility of applying the proposed system of points and solid body of variable mass to concrete physical objectives is insufficiently established.

I. V. Livartovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy of Ministry of Supply, England

3730. Zabelina, E. I., Motion of a solid body round an immovable point in the case of the Bobylev-Steklov effect (in Russian), *Trudi Donetsk. Industr. In-ta* **20,** 11-13, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12380.

Paper contains no new results, as ten cases where the equation of motion permits the inclusion of a linear particular integral (in the paper $q = 0$), were investigated by S. A. Chaplygin in his work "Linear particular integrals of the problem of the motion of a solid body supported at one point" [Collection of papers—Sobr. soch. T. 1, 1948]. The formulas contain misprints.

V. N. Skimel'

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3731. Manolov, S., A special case of the existence of small periodic motions of two penduli, subjected to uniform rotation, *J. Appl. Math. Mech. (Prikl. Matb. Mekh.)* **22,** 1, 192-197, 1958. (Reprint order no. PMM 14, Pergamon Press, 122 E. 55th St., New York 22, N. Y.)

Author considers physical pendulum system composed of two rods joined endwise, with the suspension point rotating about a fixed origin with constant angular velocity. Initial conditions leading to the existence of small periodic vibrations of the double pendulum (about the axis joining the suspension point and the origin) are investigated. Problem is special case of the similar system of n penduli studied earlier by same author [*Prikl. Mat. Mekh.* **19,** no. 4, 1955; AMR **10** (1957), Rev. 3548].

H. N. Abramson, USA

3732. Papoulis, A., Strongly non-linear oscillations, *J. Math. Phys.* **37,** 2, 147-156, July 1958.

An ingenious method is presented for investigating oscillation problems characterized by differential equations of the form

$$\ddot{X} + W(x) + \epsilon f(x, \dot{x}, t) = 0, \qquad [*]$$

in which ϵ is a small parameter. The solution of the reduced equation with $\epsilon = 0$ is supposed known.

The essential idea of the method consists in equating the solution of (*) at time t to the solution of the reduced equation at some other time t_1. An expansion in powers of ϵ is then obtained for t as a function of t_1, enabling the solution to be constructed by inversion of this functional relationship.

This procedure is applied in detail to both free and forced oscillations of autonomous (translation-invariant) systems and to the classical problem of small nonlinearities. In the latter case, results of Krylov and Bogolyubov are expeditiously recovered.

J. W. Butler, USA

3733. Schmieden, C., Nonlinear vibration with two degrees of freedom (in German), *Ing.-Arch.* **25,** 4, 292-302, June 1957.

Author points out the difficulty of the general problem of two coupled pendulums for finite amplitudes and proposes to investigate a special case of two coupled pendulums (nonlinear) of Duffing's type having equal lengths but arbitrary ratios of masses. He shows that for such a system there exist periodic solutions for finite amplitudes when the fundamental oscillation and the higher harmonic are in a rational ratio with respect to each other.

The paper is of a purely mathematical character and cannot be abstracted. It is sufficient to mention that the initial system, through a series of transformations, is reduced to a form in which the amplitudes of the fundamental oscillation and of the harmonic can be expressed in terms of a series arranged according to the ascending powers of the parameter β, the coefficient of the cubic term in these equations. Carrying out these calculations, author shows that interesting cases appear when the coefficient α of the accelerational coupling between the pendulums is a rational number. He investigates in detail two cases: (a) when $\alpha = 4/5$ and (b) $\alpha = 3/5$. In particular it is shown that for small oscillations one can add the fundamental and the harmonic with arbitrary amplitudes and still obtain the normal mode oscillation. In the nonlinear case one obtains several periodic solutions around this particular value of α. Calculations are also carried out for small values of α.

Conclusions are based on the results of very long manipulations with series solutions, and neither physical significance nor any experimental confirmation of these results is given in the paper.

N. Minorsky, France

3734. Morris, G. R., A differential equation for undamped forced non-linear oscillation. Part II, *Proc. Camb. Phil. Soc.* **54,** 4, 426-438, Oct. 1958.

A continuation and enlargement of the previous paper under the same title which studied solutions of the equation $\ddot{x} + 2x^3 = e(t)$ in which e is even and has least period 2π. Further detailed properties and characteristics of these solutions are presented in a set of fifteen lemmas and two theorems.

M. G. Scherberg, USA

3735. Lykova, O. B., Single frequency vibrations in systems with many degrees of freedom, close to those capable of precise integration (in Russian), *Dopovidi Akad. Nauk URSR* no. 1, 8–12, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12396.

An examination is made of the system of differential equations

$$\frac{dx_k}{dt} = X_k(x_1, \ldots, x_n) + \epsilon X_k^*(t, x_1, \ldots, x_n, \epsilon) \quad (k = 1, \ldots, n) \qquad [1]$$

where ϵ is a small parameter.

The functions on the right-hand side of system [1] are assumed to be analytical, periodical with t with a period 2π, and controlled in position by a curve

$$x_k = x_k^0(wt + \varphi, a), \quad \epsilon = 0 \quad (k = 1, \ldots, n)$$

in a space of $(n + 1)$ dimensions.

It is assumed that for a system of undisturbed equations there is known a two-parameter family of periodic solutions with a period of $2\pi/w$ relative to t, and that for a system of equations in variations corresponding to this periodic solution, two characteristic exponents are equal to zero, while the remainder have negative real parts, linearly independent of each other. With these assumptions operating there is built up a two-parameter family of approximate particular solutions of system [1] which is close to the orbit of the family of periodic solutions when the values ϵ are fairly small.

M. E. Temchenko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3736. Krasnosel'skii, M. A., Application of methods of nonlinear functional analysis in some problems on the periodic solutions of equations of nonlinear mechanics (in Russian), *Dokladi Akad. Nauk SSSR (N.S.)* **111**, 2, 283–286, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12394.

Starting from the point that in every system of ordinary differential equations it is possible to compare some equation with a completely continuous operator in a certain functional zone, the solution of which determines the periodic solution of the system, author applies the methods of nonlinear functional analysis to the investigation of a number of problems in nonlinear mechanics. Thus, examining systems of the form

$$\ddot{x}_i + g_i(t, x_1, \ldots, x_n, \dot{x}_1, \ldots, \dot{x}_n) = 0 \quad (i = 1, \ldots, n) \qquad [1]$$

author goes over to the system of integral differential equations

$$x_i(t) = \int_0^{2\pi} K_i(t, s)\,\{\alpha_i x_i(s) + g_i[s, x_1(t), \ldots, x_n(t), \dot{x}_1(t) \ldots, \dot{x}_n(t)]\}ds \qquad [2]$$

where $K_i(t, a)$ is Green's functions of operators $\ddot{x} - \alpha i x$ for boundary conditions.

Systems of type [2] are conveniently examined in different zones of vector functions. The nonlinear operators determinable by means of the right-hand side of the equations appear to be generally completely continuous, and capable of differential treatment. In a number of cases these nonlinear operators possess invariant sub-zones and in such a case the examination of equations of type [2] permits the establishment of more exact corroboration than does examination by the usual methods of direct systems of type [1].

With the aid of the given method for system [1] a series of theorems is substantiated, as for instance: If in system [1] the functions g_i are continuous and periodic in t and, in addition fulfil condition

$$\sum_{i=1}^{n} x_i g_i(t, x_1, \ldots, x_n, y_1, \ldots, y_n) \leqslant \alpha \sum_{i=1}^{n} x_i^2 + b \sum_{i=1}^{n} |y_i|^{2-\gamma} + e \qquad [3]$$

where a, b, c and γ are certain numbers, with $0 < \gamma < 2$, $\alpha < 0$, then system [1] has at least one periodic solution. A number of more powerful theorems is substantiated for the case when the values of g_i are odd numbers. Systems are also examined which contain a small parameter. The investigation of these systems merges with the following problem (in the terminology of operator equations). The operator $A\varphi + B(\varphi, \epsilon)$ is examined, where $B(\varphi, 0) \equiv 0$. The combination of immovable points of operator $A\varphi$ is known; the immovable points $\varphi(\epsilon)$ of operator $A\varphi + B(\varphi, \epsilon)$ are sought, which with $\epsilon \to 0$ move over to the immovable points of operator $A\varphi$. The concepts put forward permit also of adducing evidence of a series of nonlocal theorems on the existence of periodic solutions in autonomous systems of the form

$$\ddot{x}_i + g_i(x_1, \ldots, x_n, \dot{x}_1, \ldots, \dot{x}_n) = 0 \quad (i = 1, \ldots, n) \qquad [4]$$

or the form $\dot{x}_i + g_i(x_1, \ldots, x_n) = 0 \quad (i = 1, \ldots, n)$.

Yu. A. Mitropol'skii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3737. Mitropol'skii, Yu. O., Influence of elastic elements with a non-linear characteristic on small vibrations in some gyroscopic systems (in Russian), *Nauk. Zap. Kievsk. In-ta* **13**, 8, 107–114, 1954; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11250.

Equations are deduced for the small vibrations of an elastic shaft fitted with a disc in the presence of elastic elements with a nonlinear characteristic. The author claims that in the presence of nonlinear members different resonance phenomena can be shown.

D. R. Merkin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Instrumentation and Automatic Control

(See also Revs. 3732, 3883, 4047, 4109, 4128, 4148)

3738. Neumark, S., Operational formulae for response calculations, *Aero. Res. Counc. Lond. Rep. Mem.* 3075, 44 pp., + 9 figs., 1958.

Functions with operational equivalents which are rational algebraic fractions with denominators of degree n, $n = 1, 2, 3, 4, 5, 6$, are systematically tabulated to eliminate the algebraic manipulations involved in expressing them in partial fractions. The formulas and rules used to derive the operational equivalents are explained and a number of examples to illustrate the use of the tables have been worked out. The tables were produced to serve the needs of those engaged in response calculations associated with the design of aircraft.

Reviewer considers that the author's decision to define the operational equivalent of the function $F(t)$ by $\phi(D) = D\int_0^\infty e^{-Dt}F(t)\,dt$ rather than as a Laplace transform is a retrograde step which tends to perpetuate the confusion which he recognizes exists. The Laplace transform is now invariably used in the literature on electrical and servo applications.

J. Fulton, Scotland

3739. Jenkins, D. P., Complex variable applications to certain coupled systems, *Aero. Res. Counc. Lond. Curr. Pap.* no. 393, 15 pp., 1958.

It is shown that the solutions of similar differential equations which are coupled together can be expressed in terms of the solutions of a single differential equation, possibly containing complex parameters, but of the same order as each separate equation. Some implications of this result are discussed, and Nyquist's criterion is generalized to study the stability of constant parameter systems of this type. From author's summary

3740. Tuzov, A. P., The total stability of a control system (in Russian), *Vestn. Leningrad In-ta* no. 1, 57–75 + p. 209, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12395.

The following system of equations is examined:

$$\frac{dx}{dt} = a_{11}x + a_{12}y + a_{13}z + f(y)$$

$$\frac{dy}{dt} = a_{21}x + a_{22}y + a_{23}z \qquad [1]$$

$$\frac{dz}{dt} = a_{31}x + a_{32}y + a_{33}z$$

where a_{ik} are constants, the function $f(y)$ satisfies the conditions of the uniqueness of the solution of the system [1] and, in addition,

$$\alpha y^2 < yf(y) < \beta y^2 \quad \text{for} \quad y \neq 0;\ f(0) = 0$$

α, β are the limits change of parameter a, when the characteristic equation of system [1] (with substitution of $f(y) = ay$) has roots with negative real parts. Nine cases are examined, corresponding to the different correlations between the parameters a_{ik}. The conditions of asymptotic stability of system [1] both for "the whole" and "the large" are introduced.

Author refers to works devoted to the same theme as the abstracted article, but does not give a comparison of the results obtained by him in the various cases examined with the results on record. Such a comparison shows that some of the cases examined merge with those looked into previously. The perusal of the article is made more difficult by the fact that the numerous cases examined have not been classified according to the smaller number of invariant features. N. N. Krasovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3741. Gurin, A. I., Stability of steady and settled motions (in Russian), *Ucb. Zap. Mosk. Gor. Ped. In-ta* **49,** 69–97, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12419.

In addition to the exposition of the known educational material, two mechanical problems are investigated: (1) Stability of a monorail gyroscopic carriage. This is solved by means of the usual method of examination of the characteristic equation. (2) Stability of the motion of inertia of a solid body with one fastened fixed point about the minor axis of the inertia ellipsoid. The result obtained is the equivalent of the Poinceau result. The article does not reproduce the necessary references.

G. K. Pozharitskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3742. Minina, O. M., Elimination of self-oscillation in trace systems according to position with the air of nonlinear transformers (in Russian), Sb. Rabot po Avtomatika i Telemekhan., Moscow, Akad. Nauk SSSR, 1956, 42–51; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12412.

In trace systems the value of the coordinates is limited by the structure of the components of the system. These difficulties may be the cause of the appearance of self-oscillations when there are large changes in signal strength. The problem is investigated of the suppression of self-oscillation in a trace system according to situation, for which purpose use is made of an asynchronous a c motor. Author examines the system on the assumption that the features of the motor can be presented approximately with the aid of rectilinear cuttings sections. Excluding the time factor from the system of differential equations, author obtains differential equations of phase trajectories describing the motion process in the trace system

$$y\frac{dy}{dx} + 2by + w_0^2 x = 0 \qquad \text{(in the linear region)}$$

$$y\frac{dy}{dx} - y = \pm 1 \qquad \text{(in the region of saturation)}$$

where y is proportional to the velocity of the motor and x is proportional to the discharge (depleted) value. The author shows (1) that the self-oscillations in a system stable at small declinations can be eliminated by introducing transformers into the trace system or into the stabilizing contour; (2) that the requirements due to the characteristics of the transformers do not give rise to difficulties. S. N. Shimanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3743. Petrov, V. V., and Rutkovskii, V. Iu., Theory of the most simple servomechanisms with two retarded relays (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 2, 59–71, Feb. 1957.

Paper is concerned with multiple loop servomechanism systems possessing two relays. These relays have dead zones and pure delays (dead times). The case where a relay involves hysteresis is also covered. A proportional feedback loop around the servomotor is employed in the systems studied here. The output of the servomotor goes to the system to be controlled, and the output of this system is fed to a proportional plus derivative element or other device. One relay is at the servomotor, and the other in the controlled system part of the loop. The analysis involves a piecewise continuous study of system response with the aid of the phase plane. The paper concludes with the numerical case of a pneumatic-hydraulic servomechanism.

R. Oldenburger, USA

3744. Kutin, B. N., Calculating the correlation function of a stationary random process according to experimental data (in Russian), *Avtomatika i Telemekhanika* **18,** 3, 201–?22, Mar. 1957.

Article deals with errors in the computation from experimental data of the correlation function of a stationary random process due to the limited period of observation. Errors are estimated according to four currently used expressions for the autocorrelation function using different methods of computing their approximate values from experimental data. The derived formulas make possible the calculation of the mean square error of computation of the correlation function in relation to the argument τ and in this respect extend the results of Kharybin (1953) and Davenport, Johnson and Middleton (1952). Results thus enable the determination of the minimum time of observation T_n necessary to insure the desired degree of accuracy in computing the correlation function. The necessary formulas are derived in three appendixes.

From author's summary by Agnes H. Zaludová, Czechoslovakia

Book—3745. Kuz'min, P. I., Choice and evaluation of throttle control devices (in Russian), Gosenergoizdat, 1956, 112 pp. 3r, 20k; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12629.

This book consists of sixteen chapters and a supplement giving the characteristics of different throttle appliances: gate valve, turning slide valve, different controlling valves.

A method is put forward for the experimental determination of the resistance coefficients of throttle devices and for the design of an experimental apparatus. The influence of various factors on the coefficient of resistance of controlling devices is examined. The determination of the coefficient of resistance of the line when the throttle is fully open is a subject of investigation.

A determination is made of the flow at any position of the throttling device, taking into consideration the coefficient of resistance of the line. An examination is made of the design details of throttling devices—change of the relative plane of the inlet section of the controlling device and dependence on the quantity passed by the valve.

Recommendations are made in regard to the evaluation of controlling devices, and some examples of calculations are given which take into consideration the compressibility of the liquid and the variations of pressure in the controlling system.

B. I. Yan'shin
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3746. Turnbull, D. E., The response of a loaded hydraulic servomechanism, Instn. Mech. Engrs., Prepr., 16 pp., 1958.

When a hydraulic servo controls the position of a load the force required to move the load is produced by a pressure drop across the actuator. This pressure drop decreases that available to drive fluid through the control ports of the valve with the result that the speed of response is reduced.

This paper examines the effects of various types of load on the dynamic behavior of the system for both step and sinusoidal input signals.

Analytical solutions to most of the response equations are obtained, but graphical methods are occasionally used. When an inertial load is present it has been found necessary to consider the step response in the velocity-displacement or "phase" plane.

From author's summary

3747. Roston, S., Mathematical formulation of cardiovascular dynamics by use of the Laplace transform, *Bull. Math. Biophys.* **21,** 1, 1–11, Mar. 1959.

By means of the Laplace transform, the behavior of a simplified model of the cardiovascular system is mathematically formulated. This formulation allows mathematical expression of the periodicity of the cardiac output and the systemic response. With the cardiac output represented as half of a sine function cycle, the systolic aortic pressure becomes the sum of a sine term and exponential terms, while the sum of the exponential terms alone represents the diastolic pressure. The characterics of the mathematical expressions for systole and diastole are analyzed, and some relationships of potentially practical value are derived. Variation in the parameters of the system yields mathematical results consistent with the expected physical ones.

From author's summary

3748. Rathert, G. A., Jr., Creer, B. Y., and Douvillier, J. G., Jr., Use of flight simulators for pilot-control problems, *NASA Memo* 3-6-59A, 14 pp., Feb. 1959.

Comparisons have been made between actual flight results and results obtained with fixed and moving flight simulators in a number of phases of flying airplanes with a wide range of characteristics. Regions of airplane characteristics where motion stimuli are either mandatory or desirable are indicated.

From authors' summary

3749. Stewart, R. M., Some effects of vibration and rotation on the drift of gyroscopic instruments, *ARS J.* **29,** 1, 22–28, Jan. 1959.

Possible analytical procedures for evaluating vibration-induced drift in single-degree-of-freedom and in certain two-degree-of-freedom gyros are discussed. Introductory remarks include helpful review of sources of vibration. Frequency ranges and their significance are discussed.

Topics include: non-Newtonian viscosity in single-degree-of-freedom integrating-rate gyro, drift due to nonisoelastic displacements of single-degree-of-freedom gyro gimbal, noncommutative effects for single-degree-of-freedom gyro-stabilized platform, and effect of gimbal inertia as well as gyro spin axis torque coupling for two-degree-of-freedom gyro.

Author concludes that asymmetries in supporting structure, lack of orthogonality or wobbling are serious causes of drift.

No indication of knowledge of the paper by Goodman and Robinson, AMR **11** (1958), Rev. 3879, is given.

W. J. Worley, USA

3750. Magnus, K., On the stability of a heavy symmetrical gyroscope on gimbals, *J. Appl. Math. Mech. (Prikl. Math. Mekh.)* **22,** 2, 237–243, 1958. (Reprint order no. PMM 19, Pergamon Press, 122 E. 55th St., New York 22, N. Y.).

Mathematical analysis of stability of free gyroscope having vertical outer gimbal axis and gimbal rings with nonnegligible inertia, when center of gravity of rotor and gimbals is on spin axis but does not coincide with center of suspension. Treatment is restricted to configuration in which spin axis is vertical. Stability criterion is derived from Liapunov's theorem. Gyroscope is shown to be stable provided initial azimuth precession rate (i. e. rotation about outer gimbal axis) lies within certain values, which depend on distance of center of gravity from center of suspension. Since configuration analyzed corresponds to immediate neighborhood of gimbal lock position, paper seems to have little relevance to engineering problems.

R. Hadekel, England

3751. Tetel'baum, I. M., Electrical simulation of gyroscopic systems (in Russian), *Trudi Mosk. Energ. In-ta* no. 18, 259–275, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12423.

A brief account is given of the basic situation in regard to the simulation of mechanical systems on the basis of electrical analogs. An investigation is made of an eight-pole electrical scheme proposed by the author for simulating the deflection of rods. It should be noted that the generally accepted method of construction of electrical models for the study of the deflection of rod systems consists in the connection of the eight-pole units of separate rods in correlation with the boundary conditions and conditions of linking. If to the butt of two rods or parts of a rod an external force or moment of force is applied, or a concentrated mass is distributed, or if there is an elastic fastening, these are taken into account in the connections of the eight-pole units by corresponding inclusions of the elements simulating force, mass or elastic support. Taking this general method as a starting point, author examined the electrical simulation of revolving rotors in connection with their application to the problem of determining the critical speeds of elastic shafts fitted with disks. The simulation is carried out with consideration of the gyroscopic moments which appear as the consequence of the angular displacements of the axis of the rotating disks. The value identified through θ_0 emerges not as polar but as the axial moment of inertia of the disk.

G. A. Slomyanskii
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3752. Zyl'ev, B. V., Motion of a deforming gyroscope in a special case (in Russian), *Trudi Mosk. In-ta Inzh. Zh.-d. Transp.* no. 92/11, 191–200, 1957; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11220.

An investigation is made of the motion of a homogeneous round thin disk having an immovable point in the center of mass, the radius of which linearly depends on the temperature.

$$\begin{aligned}(1+\gamma t)\omega_x + 2\gamma\omega_x + (1+\gamma t)\omega_y\omega_z &= 0\\ (1+\gamma t)\omega_y + 2\gamma\omega_y - (1+\gamma t)\omega_x\omega_z &= 0\\ (1+\gamma t)\omega_z + 2\gamma\omega_z &= 0\end{aligned} \qquad [1]$$

where γ is the coefficient of the linear spreading of the disk of the gyroscope. The three first integrals of these equations were derived. Equations [1] were integrated to the end; that is, determinations were made of the angular velocities and Euler's angles. It was established that the angle of nutation, as in Euler's case, is a constant. A. P. Duvakin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3753. Cooney, J. D., Program controllers set the pulsebeat of industry, *Control Engng.* **5,** 9, 116–117, Sept. 1958.

3754. Dutcher, J. L., How the application affects the choice of program controller, *Control Engng.* **5,** 9, 118–121, Sept. 1958.

3755. Kompass, E. J., New developments in programmers, *Control Engng.* **5,** 9, 122–127, Sept. 1958.

3756. Young, L. H., Selecting punched tape or card equipment for program control, *Control Engng.* **5,** 9, 128–133, Sept. 1958.

3757. Halfhill, D., and Wildanger, E., Selecting a magnetic tape system for program control, *Control Engng.* **5,** 9, 134–138, Sept. 1958.

3758. Mathias, R. A., Putting logic to work in distributed program controllers, *Control Engng.* **5,** 9, 139–145, Sept. 1958.

3759. Morgler, H. W., Converting pulse and coded data into usable output signals, *Control Engng.* **5,** 9, 146–152, Sept. 1958.

3760. Johnson, E. C., Interpolating between programmed points to get smooth curves, *Control Engng.* **5,** 9, 153–157, Sept. 1958.

3761. Winget, J. L., Designing drive systems for use with program controllers, *Control Engng.* **5,** 9, 158–162, Sept. 1958.

3762. Cheverton, J. S., and Losch, K., Line-programmed flame cutting machine, *Control Engng.* **5,** 9, 163–164, Sept. 1958.

3763. Wooster, W. A., Tape-controlled x-ray diffractometer, *Control Engng.* **5,** 9, p. 165, Sept. 1958.

3764. Thompson, K. R., Blooming mill screwdown control, *Control Engng.* **5,** 9, 166–168, Sept. 1958.

3765. Powell, J. W., Curve followers simulate flight conditions for heat tests, *Control Engng.* **5,** 9, p. 169, Sept. 1958.

3766. Buettman, C. G., Automatic treatment of product wastes, *Control Engng.* **5,** 9, 170–171, Sept. 1958.

3767. Bingen, R., Leglise, A., and Vroman, J., Numerically controlled Belgian lathe, *Control Engng.* **5,** 9, 172–175, Sept. 1958.

3768. Kirschnick, H. J., and Hyrbyk, B. D., Punched-tape programmed automatic circuit analyzer, *Control Engng.* **5,** 9, p. 176, Sept. 1958.

3769. Van Huben, L., Package dyeing system for textiles, *Control Engng.* **5,** 9, p. 177, Sept. 1958.

3770. Bell, W. D., High-speed continuity checker, *Control Engng.* **5,** 9, 178–179, Sept. 1958.

3771. Graham, J. M., Potentiometer programmer for mechanical arm, *Control Engng.* **5,** 9, p. 180, Sept. 1958.

3772. Sharp, J. F., Punched-card proportioning of animal feed mixes, *Control Engng.* **5,** 9, p. 181, Sept. 1958.

3773. Pilnick, C., Tape-programmed testing of inertial-guidance computer, *Control Engng.* **5,** 9, p. 182, Sept. 1958.

Elasticity

(See also Revs. 3708, 3807, 3809, 3810, 3812, 3913, 3825, 3893, 3909, 3922, 3929, 3932, 3935, 4106)

3774. Miyamoto, H., On the problem of the theory of elasticity for a region containing more than two spherical cavities, *Bull. JSME* **1,** 2, 103–108, June 1958.

An extension of the method used by A. E. Green in 1940 for solving the problem of a plate with several circular holes is presented here. The method consists in expressing the harmonic functions referred to a spherical coordinate system in terms of those referred to another spherical coordinate system.

Using the Boussinesq stress function approach, a series solution is obtained for the axisymmetric case of a region with several spherical cavities whose centers lie on a straight line. Numerical calculations are given for the stress distribution along the boundaries of the cavities for the case of two spherical cavities in an elastic body under uniform tension at infinity in the direction of the axis of symmetry. E. Saleme, Argentina

3775. Paria, G., The method of Wiener-Hopf in elastic problems, *Bull. Calcutta Math. Soc.* **49,** 1, 37–42, Mar. 1957.

Consider an infinite strip plate of elastic material with unit thickness. One edge of the plate, $y = 1$, is loaded by distributed normal pressure in the plane of the plate, while the other edge, $y = 0$, is free from stresses in the range $-\infty < x < 0$ but is kept against a rigid wall in the range $0 < x < +\infty$. To find the stress distribution in the plate, the problem is resolved into two component parts. First a solution is found in which the edge $y = 1$ has the specified loadings and the edge $y = 0$ is free from stresses throughout the range $-\infty < x < +\infty$. With the primary solution thus obtained, a secondary solution is superposed in which the edge $y = 1$ is free from stresses while the edge $y = 0$ is also stress-free for the range $-\infty < x < 0$, but in the range $0 < x < +\infty$ the normal displacement is such that it neutralizes the normal displacement arising from the primary solution. The present paper applied the method of Wiener-Hopf for solving nonhomogeneous integral equation to obtain the secondary solution of the plane stress problem stated above.

There are several misprints which are of minor importance. G. C. K. Yeh, USA

3776. Teodorescu, P. P., On the plane problem of elasticity in oblique coordinates (in Roumanian), *Studii Si Cercetari Mecan. Appl.* **9,** 2, 391–410, 1958.

Author presents the theory of elasticity in oblique coordinates. Expressions for stresses, strains and displacements are given.

Indications are also presented for the case in which mass forces and thermal effects are taken into account.

D. Gh. Ionescu, Roumania

3777. Vinokurov, E. F., Determination of the deformation of a wedge under the action of an even infinite load (in Russian), *Sb. Nauch. Trudov Belorus. Politekhn. In-ta* **44,** 6, 193–198, 1954; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11874.

An elastic infinite imponderable wedge is examined, one of whose faces carries an even load while another is supported on an absolutely rigid foundation. When determining the transposition, the boundary conditions were incorrectly formulated, which, in particular, lead to the relation of the constants of the integration to the polar coordinate. In R. M. Rappoport's work [*Izv. N.-I In-ta Gidrotekhniki*, p. 36, 1948] expressions are introduced for Eri's function; the determination of the transpositions through Eri's function is carried out without trouble, using known formulas.

A. M. Kochetkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3778. Bronskii, A. P., Velocity of deformation of an inclined cylinder subjected to internal pressure (in Russian), *Vestnik Mosk. In-ta* no. 1, 13–16, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 12005.

An investigation is made of the plane problem of large deformations of a slanting thick-walled cylinder being acted on by an internal pressure $p = p(t)$. The system of equations consists of the differential equation of motion

$$\frac{\partial \sigma_r}{\partial_r} + \frac{\sigma_r - \sigma_\theta}{r} = \rho \frac{\partial^2 r}{\partial t^2} \qquad [1]$$

in which $r = r(t, r_0)$ is the distance of the particle from the axis, while the destiny ρ is constant, the plasticity conditions

$$\frac{\sigma_\theta - \sigma_r}{r} = \frac{1}{r} \frac{2\sigma_2}{\sqrt{3}} \qquad [2]$$

and the equations of incompressibility

$$r^2(t, r_0) = r_0^2 + R^2 - a^2 \qquad [3]$$

where $R = R(t)$ is the internal radius of the cylinder in moment (t). The initial conditions were taken as: where $t = OR = a$ and $dR/dt = 0$. From [1], [2] and [3] for $R(t)$ an ordinary differential equation of the second order is derived; its solution is given in a closed form. It is assumed that at some value $R/a = \epsilon_s$ the fracture of the cylinder takes place. A simple approximate formula is put forward for the time period up to fracture.

L. M. Kachanov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3779. Atsumi, A., Stress concentrations in a strip under tension and containing an infinite row of semicircular notches, *Quart. J. Mech. Appl. Math.* **11,** 4, 478–490, Nov. 1958.

Author extends Ling's solution for an infinite strip under tension containing a pair of semicircular notches [AMR **1** (1948), Rev. 230] to the case of a strip containing an infinite row of semicircular notches of equal radii placed at equal distances on the edges. The solution of the problem, a triple infinite series, is built up from two sets of fundamental solutions which are expressed in terms of double infinite series. The parametric coefficients attached to each of the fundamental sets are determined from the boundary conditions at the rim of the notches. A perturbation method is introduced to facilitate the computations, and stress-concentration factors are calculated for several cases where the radius of the notches and the distance between the centers of neighboring notches are varied.

C. C. Chao, USA

3780. Anikin, E. P., Concentration of stresses in a plate with a rectangular cutout (in Russian), *Trudi Dal'nevost. Politekh. In-ta* no. 45, 63–81, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11868.

Using the method of N. I. Muskhelishvili an investigation is made of the stress concentration beside a rectangular cutout in an infinite plate, when subjected to tension and shear, in relation to R/b (where R is the radius of the rounding of the angles of the opening, b the small side of the rectangular opening). This is accomplished by a corresponding selection of the values of coefficients $a_1, a_3, a_5 \ldots$ in the functions $\omega(\xi) = \xi^{-1} + a_1\xi^1 + a_3\xi^3 + \ldots$, performing a conforming reflection of the outward form of the rectangular opening on the outward form of the unit circle. A table is given of the coefficients of stress concentration along the outline of the rectangular opening at different values for a/b and R/b, both for the tension and the shear of the plate (a is the large side of the rectangular opening).

G. N. Savin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3781. Moran, J. P., Simulate high-Mach stresses, *Mach. Design* **31,** 6, 22–23, Mar. 1959.

At speeds above Mach 2, the stagnation temperature of air rises rapidly, adding a thermal component to air-load stresses on aluminum wing coverings. Paper shows how Convair simulates the heat and loads of high-speed flight in the structures lab.

From author's summary

3782. Naghdi, P. M., On thermoelastic stress-strain relations for thin isotropic shells, *J. Aero/Space Sci.* **26,** 2, p. 125 (Readers' Forum), Feb. 1959.

Author extends previous results, AMR **10** (1957), Rev. 2473, to include thermal effects. The defect in the usual formulation of problems of thermoelastic shells that an initially stress-free isotropic shell remain stress-free in a uniform temperature field can be avoided by assuming a particular form for the displacement. The present paper is incomplete without the author's previous results. Neither paper can be easily applied to engineering problems.

N. C. Costakos, USA

3783. Parkes, E. W., Repeated thermal stresses (in Swedish), *Tekn. Tidskr.* **88,** 37, 955–960, Oct. 1958.

Emphasis is laid on the fact that statically indeterminate structures such as airplane wings are more liable to thermal stress than statically determinate ones; structures composed of different materials are more sensitive to heating than those made of homogeneous material. Comparison of different material combinations using simple statically indeterminate model structure shows that design based on purely elastic deformation would be uneconomical. Thus importance of plastic deformation and shakedown is made obvious and illustrated with different combinations of dimensions, material properties and temperature cycles. Conditions for shakedown are indicated and results applied to limit design of a special airplane wing structure.

F. K. G. Odqvist, Sweden

3784. Bijlaard, P. P., Differential equations for cylindrical shells with arbitrary temperature distribution, *J. Aero/Space Sci.* **25,** 9, 594–595 (Readers' Forum), Sept. 1958.

The temperature is assumed to vary linearly in the radial direction, but the temperature rise in the middle plane and the radial temperature gradient may vary arbitrarily in the longitudinal and circumferential directions.

The usual stress resultants are expressed in terms of the stress causing strains (total strain—thermal strain) in the middle plane and the similarly defined changes of stress causing curvatures. Substituting the stress resultants in the equilibrium equations of the shell and comparing these with those applying to a loaded shell with zero temperature rise, external load components equiva-

lent to the prescribed temperature distribution are found. Donnell-type equations are derived with the help of these equivalent (fictitious) loads, relating the radial displacements to the derivatives of the temperature distribution. Methods of solution are indicated for some particular cases. G. Sved, So. Australia

3785. Brooks, W. A., Jr., Temperature and thermal-stress distributions in some structural elements heated at a constant rate, *NACA TN* 4306, 40 pp. + 1 table + 23 figs., Aug. 1958.

The evaluation of thermal stresses in common structural shapes (angle, channel, T- and H-sections)* requires the determination of temperature distributions in space and in time for a given thermal input. The case of constant thermal input is simple to treat analytically, in one-dimensional cases, and is of sufficient practical importance to warrant separate study. The general problem under the previously outlined conditions has been treated by the author analytically for constant physical properties. Nondimensional temperatures have been plotted against other nondimensional variables (time, space) for various geometries (*). Solutions have been obtained by Laplace transformation methods for both short and long times.

The thermal stresses are determined from a one-dimensional theory which assumes that a typical section is sufficiently far removed from the ends so that the end conditions can be neglected; plane sections remain plane and all material properties are constant. Nondimensional thermal stresses are presented in the form of charts as functions of the nondimensional variables (time, distance). These charts can be conveniently used in the analysis of experimental data. F. V. Pohle, USA

3786. Johns, D. J., Thermal stresses in thin cylindrical shells stiffened by plane bulkheads for arbitrary temperature distributions, *Coll. Aero. Cranfield Note* 83, 22 pp. + 3 figs., July 1958.

A study has been made of the thermal stresses resulting near the joint of a cylinder and internal bulkhead due to arbitrary temperature distributions in the configuration and to the consequent compatability forces and moments at the joint. The method is general enough to permit the inclusion of joint thermal resistance, but certain limitations are placed on the form of the axial temperature distribution in the cylinder.

An approximate method to determine the transient temperatures for completely general heating programs is also proposed.

From author's summary by L.-W. Hu, USA

3787. Teodorescu, P. P., On the plane problem of thermoelasticity (in Russian), *Acad. Repub. Pop. Romine, Rev. Mecan. Appl.* **3,** 3, 333–340, 1958.

After reviewing the cases of plane stress and strain, author discusses the possibility of obtaining the plane stress state under thermoelastic conditions in two cases: (1) the temperature distribution $T = T(x, y)$ throughout the body is known, and (2) the function $T = T(x, y; t)$ depends upon the equation of thermal conductivity throughout the homogeneous and isotropic body.

In the absence of heat sources, the stress function $F = F(x, y; t)$ verifies the equation

$$\Delta\Delta\left(a\Delta - \frac{\partial}{\partial t}\right)F = 0 \qquad a = \text{const.}$$

Different ways of setting the boundary conditions result in the knowledge of function F, of the normal derivative $\partial F/\partial n$, and of $\Delta\Delta F$ on the boundary. At the initial moment $t = t_0$, the temperature distribution is $T = T_0(x, y)$, which corresponds to case (1).

Paper mentions various practical problems that may be solved in this manner. A. Petre, Roumania

3788. Sirotin, Yu. I., Temperature stresses arising on the heating and cooling of monocrystals (in Russian), *Kristallografiya* **1,** 6, 708–717, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12982.

Thermoelastic stresses are determined in an isotropic elliptical cylinder, in an anisotropic plate, and in a spherical monocrystal of cubical syngony.

The solution is built with the aid of stress functions according to the method of S. G. Lekhnitskii ["Theory of elasticity of an anisotropic body," Moscow, Gostekhizdat, 1950; AMR **5** (1952), Rev. 1014] for analogous problems in the absence of temperature gradients. V. A. Lomakin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3789. Quinlan, P. M., Torsion of semi-elliptic and hollow-elliptic sections, AFOSR TN 58-883 (ARDC TN 4; ASTIA AD 203 905), 23 pp., July 1958.

Conformal mapping is used to reduce the torsion problem for hollow-elliptic and semi-elliptic sections to a potential problem in a rectangle. In each case both the appropriate stress function and the torsional rigidity are obtained in series form, and the appropriate asymptotic form of the series for the stress components is given for use where greater precision is required. Solutions developed for the hollow elliptic tube and the prolate semi-elliptic shaft check with existing solutions obtained by other methods. Solutions are also given when the above sections are cracked; the crack in each case being along the major axis extending, respectively, through the thickness of the tube and to the focus of the shaft. The torsion of an oblate semi-elliptic shaft is also included. Calculations were performed to evaluate the effects of cracking on the sections, and the results are presented in tabular form.

From author's summary by H. G. Hopkins, England

3790. Vorob'ev, N. N., Deflection and torsion of a plane crooked beam of small curvature with an arbitrary transverse section (in Russian), *Nauch. Tr. Novocherkas. Politekhn. In-ta* **29,** 43, 65–78, 1955; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13019.

Calculations are given for a beam of small curvature and a transverse section arbitrarily oriented in relation to the plane of the beam's curvature. The external forces are assumed to be arbitrarily directed or presented in the form of a distributed load or in the form of concentrated forces. The case of a section symmetrical in relation to the plane of curvature is solved by means of the general formulas as a particular case. For the construction of the basic differential equations use is made of Castigliano's theorem. Six initial parameters, entering into the expressions for the internal forces and moments acting on any section of the curved beam, are determined in each separate case from the boundary conditions. For the fastened ring, general formulas are evolved which express these parameters as functions of the external load. It is to be regretted that no examples have been put forward to show to what extent the practical calculation in the general case appears to be more complex in comparison with the solution for a beam of symmetrical section relative to the curvature plane.

N. L. Kuz'min

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3791. Belkin, V. P., Strength of the elements of a deck structure when taking into account the torsion on the supporting assembly (in Russian), *Sudostroenie* no. 3, 11–17, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11914.

A solution is given of the problem dealing with the strength of a rectangular plate reinforced by rigid ribs under the action of longitudinal compression forces. The problem is solved by the energy method. The fastenings on the longitudinal edges are as-

sumed to be elastically embedded on the transverse, freely supported. The form of the elastic surface of the plate, a half-wave when it is bulging, is taken as

$$W = A\left[(1-\kappa)\cos\frac{\pi y}{b} + \kappa\cos^3\frac{\pi y}{b}\right]\sin\frac{\pi x}{a}$$

where A is the parameter of the deflection, x the coefficient characterizing the degree of fastening, a and b the length of the half-wave and width of the plate, respectively. The solution of the problem resolves itself into two stages. In the first stage the problem's solution proceeds without taking into account the bond between the elastic fastening and the longitudinal assembly. Curves are drawn which, for a plate with a given ratio for the sides and degree of fastening of the longitudinal edges, enable determinations to be made for the number of waves and for the critical load. In the second stage the influence is established of the extent of fastening on the elastic and geometrical characteristics of the ribs reinforcing the plate. With the aid of the formula obtained for the determination of x and the above-mentioned curves, the problem, in every concrete case, resolves into a very simple calculation. A. V. Sachenkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3792. Horvay, G., Biharmonic functions of the semi-infinite strip (in French), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **6**, 16-19.

If the external forces act on a portion of the elastic body and are in equilibrium, then the state of stress at a sufficiently far removed point of the body does not essentially depend on the distribution of the external forces. This assertion is the Saint-Venant principle. Author proves this principle for the plane state of an infinite wedge, the corner of which is truncated. The external forces are acting on the truncated corner. The proof is carried out on purely mathematical grounds.

J. Barta, Hungary

3793. Iwaki, A., and Mori, M., On the distribution of surface roughness when two surfaces are pressed together, *Bull. JSME* **1**, 4, 329-337, Nov. 1958.

Because of the random arrangement of surface roughness, a statistical approach is used in analyzing several parameters which influence the roughness of and contact between pressed surfaces. The roughness distribution, its change under pressure, the contact ratio and gap length are each studied. Distribution functions are used to estimate number of contact points. Coefficients of roughness change are determined experimentally from the relative hardness of two metals, and the contact ratio established from pressure and hardness readings. Numerous charts and formulas present the information uncovered. J. P. Vidosic, USA

3794. Strakhovich, K. I., The dynamics of elastically viscous media (in Russian), *Sb. Trudi Obshtchetekhn. Kafedry Leningrad Tekhnol. In-ta Kholodiln. Prom-sti* **12**, 58-71, 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9450.

If, in the general equation of motion of the mechanics of continuous media, the stress tensor

$$T = T_y + T_m$$

is introduced, in which

$$T_y = 2\mu\,\mathrm{def}\,\bar{u} + \lambda\, I\,\mathrm{div}\,\bar{u}$$

is the stress tensor for an elastic body, while

$$T_m = 2\mu'\,\mathrm{def}\,\bar{v} + \lambda'\, I\,\mathrm{div}\,\bar{v}$$

is the stress tensor for liquids and gases, the differential equations of motion for an elastic-viscous medium (limited to the case of small displacements) are obtained in the form

$$\frac{\partial^2\bar{u}}{\partial t^2} = \bar{K} = \frac{\nabla p}{\rho} + \frac{\lambda+\mu}{\rho}\nabla\,\mathrm{div}\,\bar{u} + \frac{\mu}{\rho}\nabla\bar{u} + \frac{\lambda'+\mu'}{\rho}\nabla\,\mathrm{div}\,\frac{\partial\bar{u}}{\partial t} + \frac{\mu'}{\rho}\nabla\frac{\partial\bar{u}}{\partial t} \quad [1]$$

In the above, $\bar{u}$ and $\bar{v} \approx \partial\bar{u}/\partial t$, are the vectors of displacement and velocity, $\bar{K}$ is the specific volume force, λ and μ are the Lamé coefficients, ρ the density, λ' and μ' the Navier-Stokes viscosity coefficients. Putting

$$\nu = \frac{\mu}{\rho};\quad \nu' = \frac{\mu'}{\rho};\quad \kappa = \frac{\lambda+\mu}{\rho};\quad \kappa' = \frac{\lambda'+\mu'}{\rho};\quad \frac{\nabla P}{\rho} = \nabla\Pi';\quad \bar{K} = -\nabla U$$

and representing the vector $\bar{u}$ as the sum of the gradient and the vortex ($\bar{u} = \nabla\varphi + \mathrm{rot}\,A$), we can replace [1] by a system of two equations

$$\frac{\partial^2\varphi}{\partial t^2} - (\kappa'+\nu')\Delta\frac{\partial\varphi}{\partial t} - (\kappa+\nu)\nabla\varphi + U + \Pi' = 0$$

$$\frac{\partial^2\bar{A}}{\partial t^2} - \nu'\nabla\frac{d\bar{A}}{dt} - \nu\nabla\bar{A} = 0$$

A solution of these equations for some particular cases (free and constrained oscillation, constant field of force) is given. As a result, author arrives at conclusions: that in an elastic-viscous medium the referred frequencies of free oscillation k cannot exceed the following values:

$$k_1 = 4\frac{\kappa+\nu}{(\kappa'+\nu')^2} \qquad \text{(longitudinal oscillations)}$$

$$k_2 = 4\frac{\nu}{\nu'^2} \qquad \text{(transverse oscillations)}$$

For higher values of k, only aperiodic, fading oscillations are possible. The amplitudes of free oscillation fade exponentially, with a logarithmic decrement equal to k^2; their velocities of propagation, c_1 and c_2, decrease with increasing k, according to the relationships

$$c_1 = \sqrt{\frac{\lambda+2\mu}{\rho}\left(1 - \frac{k(\kappa'+\nu')^2}{4(\kappa+\nu)}\right)} \qquad \text{(longitudinal oscillations)}$$

$$c_2 = \sqrt{\frac{\mu}{\rho}\left(1 - \frac{\nu'^2}{4\nu}k\right)} \qquad \text{(transverse oscillations)}$$

becoming zero for $k = k_1$, and $k = k^2$, respectively. The rate of propagation of the constrained oscillations is approximately proportional to the square root of the frequency. The amplitudes of forced oscillation decrease according to e^{-Dx}, with increasing distance x from the surface of excitation of the oscillations, where

$$D = \frac{\bar{k}\sqrt{\sqrt{\alpha^2+\beta^2\bar{k}^2} - \alpha}}{\sqrt{2}\sqrt{\alpha^2+\beta^2\bar{k}^2}}$$

$\bar{k}$, being the frequency of forced oscillation, $\alpha = \kappa + \nu$, $\beta = \kappa' + \nu'$.

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Viscoelasticity

(See also Revs. 3778, 3794, 3838, 3899, 3906, 4106)

3795. Budiansky, B., Extension of Michell's theorem to problems of plasticity and creep, *Quart. Appl. Math.* **16**, 3, 307-309 (Notes), Oct. 1958.

Author extends theorem of Michell which states the conditions under which the generalized plane stress distribution in a multiply-connected sheet of linear, isotropic, elastic material subjected to prescribed boundary stresses is independent of Poisson's ratio. Author states that theorem may be useful in the initial formulation of certain problems and in photoplasticity. A slight misprint occurs in the last equation on p. 308. Equation should read

$$J = -\sum_{i=0}^{N} K_{\alpha}^{(i)} P_{\alpha}^{(i)}, \text{ where } P_{\alpha}^{(i)} = \oint_{C_i} T_{\alpha}^{(i)} dS.$$

A. P. Boresi, USA

3796. Schumann, W., On isoperimetric inequalities in plasticity and creep, *Quart. Appl. Math.* **16, 3,** 309–314 (Notes), Oct. 1958.

Author proves isoperimetric inequality $P \leqq 6\pi M_0$ for a material exhibiting the Tresca yield condition, where P is the total limit load, M_0 is the yield moment of a thin, perfectly-plastic, simply-supported, uniformly loaded plate of arbitrary shape and connection. The isoperimetric inequality which relates a circular domain to an arbitrary domain is used to estimate the limit load in the arbitrary plate. Author also proves that the above inequality holds for the v. Mises' yield criterion, but he notes that the isoperimetric property is lost. Noting the analogy between the problem of minimum weight of a sandwich plate and the problem of torsion, author establishes isoperimetric inequality $V \leqq (pA^2)/(4\pi\sigma_0 H_0)$, where V is the volume, H_0 is constant core thickness, σ_0 is the yield stress, A is the area, and p is the limit load per unit area. For very long narrow domains, the isoperimetric inequality gives a poor bound; author conjectures that Steiner's symmetrization may be useful in this case. Reviewer believes the note to be an interesting contribution to the theory of perfectly plastic plates.

A. P. Boresi, USA

3797. Narasimhamurthy, P., An analytical investigation of creep under combined loadings, *Aircr. Engng.* **29,** 345, 346–349, Nov. 1957.

Present paper deals with an analytical formulation of the laws of creep under combined loading. The study rests upon the ideas and procedures of plastic flow, and the assumptions are made that the material is isotropic, the time-dependent deformation occurs at constant volume, and the creep behavior in tension and compression is the same. A consequence of the second assumption is that the energy of deformation is distortional. Yielding is said to take place when the distortional energy reaches a critical value. Both the distortional energy and its critical value of yielding are functions of time and temperature. Based upon this approach a new set of six strain rate versus stress equations are derived which involve functions and constants obtainable from uni-axial load creep tests. Some comparisons with experiment are given and the agreement is remarkably good. Finally there is brief mention of the matter of anisotropic creep deformation.

R. L. Bisplinghoff, USA

Plasticity

(See also Revs. 3795, 3796, 3797, 3813, 3854, 3879, 3893, 3909, 3910, 3938, 3942, 3969, 4222)

3798. Kliushnikov, V. D., On plasticity laws for work-hardening materials, *J. Appl. Math. Mech. (Prikl. Math. Mekh.),* **22,** 1, 129-160, 1958. (Reprint order no. PMM 9, Pergamon Press, 122 E. 55th St., New York 22, N.Y.)

Paper is a review of the development of mathematical theories of plasticity taking into account work hardening. Both Hencky-Nadai deformation theory and modern flow theories are discussed. Presentation is tied mainly to more recent results regarding properties of the yield surface: e.g., conicity of the yield surface is discussed at some length. Reference is also made to recent experiments on the shape of the yield locus.

J. Hult, Sweden

3799. Kadashevich, Iu. I., and Novozhilov, V. V., The theory of plasticity which takes into account residual microstresses, *J. Appl. Math. Mech. (Prikl. Math. Mekh.),* **22,** 1, 104–118, 1958. (Reprint order no. PMM 7, Pergamon Press, 122 E. 55th St., New York 22, N.Y.)

Strain hardening and Bauschinger effect are described in presented theory, originally due to Ishlinskii. The yield locus is assumed as $(1/2\sigma_{ij}^{0}\sigma_{ij}^{0})^{1/2} = T^0$, where $\sigma_{ij}^{0} = \sigma_{ij} - s_{ij}$, and σ_{ij}^{0} denotes the deviator of σ_{ij}^{0}. Here s_{ij} denotes the translation of the center of the yield locus in the σ_{ij} space, i.e. the yield locus is assumed to remain similar to its initial form, but to undergo a translatory displacement during plastic flow. A dry frictional model is used to support the hypothesis $\epsilon_{ij}^{p} = (1/2g)\cdot s_{ij}$, where g is a function of the invariants of s_{ij}. The Reuss hypothesis is replaced by $d\epsilon_{ij}^{p} = \sigma_{ij}^{0}\cdot d/(T^0)$. Elastic strains are assumed to follow Hooke's law.

The theory is applied to different loading programs on a thin-walled circular cylinder. Comparison to experimental results by Budiansky & al. [AMR **6** (1953), Rev. 3064] shows better agreement than deformation theory and flow theory (notations (a) and (b) in Fig. 6a seem to be interchanged). Presented theory also predicts plastic untwisting in tubes that was observed by Feigen [AMR **9** (1956), Rev. 1101].

J. Hult, Sweden

3800. Olszak, W., The inversion mapping as applied in the theory of plasticity (in English), *Arch. Mech. Stös.* **10,** 3, 417–440, 1958.

Author uses the coordinate transformation known as inversion to solve problems in elasticity and plasticity. Reviewer doubts whether this paper is of practical value because the author makes the artificial assumption of an inhomogeneous material whose yield stress depends upon one of the coordinates.

D. R. Bland, England

3801. Lengyel, P., and Bakondi, J., Quick dimensioning of bent reinforced girders of square cross section by plasticity theory (in Hungarian), *Mélyépítéstudományi Szemle* **7,** 9/10, 325–327, Sept./Oct. 1957.

For a plastic (uniform) stress distribution in a rectangular reinforced-concrete beam the moment-arm ratio (moment arm/effective height) can be calculated with a small, safe error from the formula $j = 1 - 0.2\, M/M_0$ for $M/M_0 \leqq 1$. Here M is the design moment and $M_0 = 0.4\, db.\ 0.8\, d\sigma = 0.32\, bd^2\sigma$ is the moment for $j = 0.8$.

G. Sved, Australia

3802. Smirnova, T. N., and Terminasov, Yu. S., X-ray diffraction investigations on the plastic deformation of metals under static and dynamic compression (in Russian), *Izv. Akad. Nauk SSSR, Ser. Fiz.* **20,** 6, 664–670, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 12216.

An X-ray diffraction investigation was carried out on iron, aluminum and steels Mark St 2 and Mark U8. Cylindrical test samples with marked off lengths were annealed (the steel and iron at 700°, the aluminum at 350° for a period of 1.5–2 hrs) and were deformed. The dynamic deformation was carried out on a high-speed piledriver built by N. N. Davidenkov (for the iron and steel test samples) and an Amsler impact machine (for the aluminum test samples). The static deformation took place on a 60-ton Amsler press and a 35-ton universal press. Investigations were made of lines (310) and (220) for the iron and steel test samples and lines (420) and (331) of the aluminum test samples obtained in K_{α}-irradiation cobalt in a reflex camera. Curves were drawn to show the dependence of the broadening of the lines on the degree

of deformation and the relations of intensity $I_{310}I_{220}$ and $I_{420}I_{331}$ to the degree of deformation. It was shown that the broadening of the lines at one and the same (degree of) deformation is greater in the case of statically deformed material than in dynamically deformed, which can be explained by the local thermal relaxation, while the relative intensity is greater in the case of the dynamically deformed. The increase in broadening of the lines in all cases ceases at 30% of deformation. It is considered as established that the residual distortions of the crystal lattice do not appear to be the direct cause of the metal's destruction.

V. M. Kardonskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3803. Kal'ner, D. A., Method for the determination of the relation between the velocity of propagation of plastic deformation (in Russian), *Zav. Lab.* **22**, 9, 1086–1089, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 12225.

In the title of the article a misprint is assumed: it should read: "Method for the determination of the relation between the velocity of propagation of elastic and plastic deformation." The description of a steel wire was carried out by means of a transverse impact of great velocity. The distribution of the residual deformations was established by measuring the diameters of the wire after fracture. The relation between the velocities of propagation of deformation was calculated by means of Kh. A. Rakhmatulin's theory [*Prikl. Mat. Mekh.* **9**, no. 4, 1945; **10**, no. 6, 1946].

V. L. Biderman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3804. Malmeister, A. K., Plasticity of a quasi-isotropic body (in Russian), Questions of dynamics and dynamic strength, no. 4, Riga, Akad. Nauk LatvSSR, 1956, 37–38; *Ref. Zh. Mekh.* no. 9, 1957, Rev. 10842.

A theory of plasticity in its final formulation is proposed, very close to the theory of slip by Batdorf and Budiansky [*NACA TN* 1871, 1949], but in essence differing from the latter. Batdorf and Budiansky's theory, as is known, is based on the transfer of the principal items of the plasticity phenomenon of a monocrystal in a continuous medium. The basic property of the plasticity of a monocrystal is held to be the relation of the irreversible shear in each system of slip based only on the history of the component of tangential stress in the stated system of slip and the principle of independence of each system of slip. This property of systems of slip is imparted to each direction of the continuum in the vicinity of the point being investigated of the continuous medium. In consequence of such a presentation the general plastic deformation at the point being examined is expressed in the form of an integral of the stresses along the surface of a sphere of unitary radius and by the angle on this sphere.

The author when building his theory proceeds principally from other concepts and his approach cannot be treated as a transfer to a continuum of the properties of plasticity of monocrystals. In this sense the proposed theory cannot be considered as physical, even in the narrow meaning given to this word in the theory of slip, and appears to be in reality of the phenomenon type. The physical aspect, the actuality of which is established at the expense of the frequent use of such words as "slip" and "twinning" in the paper, has factually no meaning. Author's main assumption appears to be the hypothesis regarding the independence of the action (plastic behavior) of all the elementary layers, parallel to any surface, passing through the point being examined on the continuum. It is assumed that the plastic shear on each of these surfaces depends only on the value of the tangential stress in the given surface. Thus, the general plastic deformation is comprised of the sums of deformations due to shear in each elementary layer and is presented in the form of an integral along the surface of a sphere of unitary radius.

The final formulation of the theory differs from the formulation of the theory of slip only by the substitution of one integration (by the angle on the sphere's surface) by a final expression. The necessity of the last integration in the theory of slip is due to the basic assumptions included in its basis, and the author's assertion that such integration in the theory of slip is unsubstantiated appears to be wrong. A method is given for the approximate integration of the proposed correlations between the stresses and the deformations for the case when the maximum tangential stresses exceed by a little the limiting elastic tangential stresses. The unknown function entering into the correlations is determined by experiment with a simple loading. An example is investigated of the torsion of a thin-walled tube with subsequent tension, and a final expression is given for the intensitivity of the plastic deformation at both stages of loading. Comparison with the experimental results is confined to the indication of the agreement of the theory with one of the deductions of V. A. Sveshnikov's experiments.

V. D. Klyushnikov

Courtesy Referativnyi Zhurnal, USSR
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Rods, Beams and Strings

(See Revs. 3790, 3845, 3851)

Plates, Shells and Membranes

(See also Revs. 3775, 3778, 3780, 3782, 3784, 3786, 3837, 3839, 3875, 3929, 3930)

3805. Bassali, W. A., The analysis of singularly loaded and rigidly clamped thin elastic slabs with curvilinear boundaries. Part I, *Proc. Camb. Phil. Soc.* **55**, 1, 121–136, Jan. 1959.

Problems of bending of clamped thin elastic plates subjected to concentrated forces and couples at interior points are solved by the complex variable method. Shapes of the plates under consideration are those determined by the mapping functions $z = c\rho/(1 + m\rho^{p+1})$ and $z = c\rho(1 + m\rho^{p})$, p being a positive integer. Due to the simplicity of these functions, closed-form solutions are obtained. Numerical results are, however, not included. The form of the singular part of the complex functions corresponding to a concentrated force at an interior point is believed to have been used first by A. I. Lurie [*Prikl. Mat. Mekh.* **4**, 1, 93–102, 1940], although his work is often not quoted.

Y.-Y. Yu, USA

3806. Heinen, R., Contribution to the calculation of influence surfaces of oblique plates (in German), *Ing.-Arch.* **26**, 4, 268–287, Aug. 1958.

Influence surfaces of plates having the form of a paralellogram are set up according to the method of F. Schulze-Grunow [*ZAMM* **33**, p. 227, 1953; AMR **7** (1954), Rev. 3517]. In case of an equilateral parallelogram with internal angles of $1/3\,\pi$ and $2/3\,\pi$ and with fixed edges, the influence surfaces both for the deflection and bending moments are calculated.

G. Sonntag, Germany

3807. Wells, J. D., Three-dimensional duct system, *Engineering* **186**, 4838, 704–707, Nov. 1958.

A duct system involving pivoted joints is described for permitting relative motion due to thermal expansion in a piping system having sufficiently large-diameter ducts so that standard procedures for incorporating flexibility into the piping are not practical. A Hooke-type universal joint design is discussed employing a bellows for

one of the degrees of freedom. Equations are derived for the geometry of the hinged duct system and the resulting forces, moments and stresses. The common problems of piping—cost, leakage and failure—and their solution by the accommodation of motions within the scope of ordinary expansion joints or U-bends have been the problems most frequently encountered by American designers. The joint system described appears to be an additional solution for severe operating conditions. F. Freudenstein, USA

3808. Bassali, W. A., Bending of a thin circular plate under hydrostatic pressure over a concentric ellipse, *Proc. Camb. Phil. Soc.* **55,** 1, 110–120, Jan. 1959.

On the basis of the classical thin-plate theory, the title problem is solved by the complex variable method. The plate may be either clamped or simply supported. Complex functions involving an infinite series are determined for the problem. No numerical examples are given. Y.-Y. Yu, USA

3809. Quinlan, P. M., Rectangular plates, a new approach, AFOSR TN 58-259 (ASTIA AD 154 163), 43 pp. + 4 figs., Jan. 1958.

Author considers small-deflection theory for a concentrated load and concentrated torque under several edge conditions, obtaining the usual infinite series involving hyperbolic functions on one coordinate and trigonometric functions on the other coordinate. The primary contribution appears to be the use of a limiting series to improve the convergence of the original series in the region of the concentrated load. The limiting series is obtained by replacing the hyperbolic functions by an appropriate exponential function to obtain a new series which can be summed for the case of the transverse bending moments. Subtracting the two series gives a new series which converges rapidly.

B. E. Gatewood, USA

3810. Quinlan, P. M., Multi-ring plates, AFOSR TN 58-211 (ASTIA AD 154 112), 26 pp., Jan. 1958.

In the differential equation for the elastic deflection of a circular plate, the normal load on the plate and the plate thickness occur only in the nonhomogeneous term of the equation. Author takes advantage of this fact and uses an operator procedure to solve the equation for discontinuities in load and thickness for various edge conditions. The load and thickness are functions of the radius only. B. E. Gatewood, USA

3811. Serebryanyi, R. V., On the calculation of hinged plates placed on an elastic layer of finite thickness (in Russian), *Osnovania i Fundamenty* no. 21, 12–16, 1958.

Paper deals with the calculation of hinged foundation plates placed on a layer of finite thickness. General relations are established for the case of two semi-infinite plates hinged along a straight line. Based on these relations, author discusses the particular case of two plates placed on a semi-infinite layer and subjected to a concentrated vertical load on the junction line.

R.-J. Bally, Roumania

3812. Sokolowski, M., Some plane problems with boundary conditions in terms of displacements (in English), *Arch. Mech. Stos.* **9,** 4, 439-454, 1957.

Elaborating his earlier publications on the subject of the elasticity of orthotropic plates, author derives the stress and strain equations for some plane problems in the case of rigidly fixed boundaries, from the Airy stress functions and the Galerkin displacement functions, assuming orthotropic material. Thus he considers: A semiplane with clamped edge, with a force perpendicular to, and parallel with, the fixed boundary; an infinite strip with clamped edges, symmetrically loaded by two forces, parallel with the fixed boundaries and perpendicular to these boundaries; a rectangle with clamped edges, loaded in the center, and an infinite quadrant loaded parallel to one of the boundaries.

F. C. de Nie, Holland

3813. Olszak, W., and Murzewski, J., Elastic-plastic bending of non-homogeneous orthotropic circular plates (II), (in English), *Arch. Mech. Stos.* **9,** 5, 605–630, 1957.

The differential equations pertinent to the title problem are developed for the class of problems in which axial symmetry exists. Solutions of these equations for the three ranges elastic, elastic-plastic, and fully plastic are discussed. Two specific examples are worked out. Authors appear to have presented a sound approach to a difficult problem; some of the terminology employed by the translator is open to question. M. E. Raville, USA

3814. Baikov, V. T., Lopovok, B. N., and Irapezin, I. I., Deflection of an oblique-angled plate (in Russian), *Trudi Mosk. Aviats. In-ta* no. 69, 3–10, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13072.

The problem of the deflection of a plate in the form of a parallelogram with fastened edges under the action of an evenly distributed load is solved by the Kantorovich method.

I. E. Sakharov

Courtesy Referativnyi Zhurnal, USSR Translation, courtesy Ministry of Supply, England

Book—3815. Aas-Jakobsen, A., The computation of cylindrical shells [Die Berechnung der Zylinderschalen], Berlin, Springer-Verlag, 1958, xii + 160 pp. DM 22.50.

This is an excellent book written by a construction engineer who has calculated many shell roof buildings in Norway, his native country. So the theory developed is governed by the exigencies of construction practice.

Contents: 1. Fundamentals of shell theory: Here, based on Flügge's work, the fundamental equations of bending of circular cylindrical shells without and with ribs are developed. 2. Surface loads; Membrane theory: Deals with the solution of the inhomogeneous equation. 3. Isotropic shells loaded at longitudinal edge. 4. Shells with annular ribs loaded at longitudinal edge. In these two chapters, the laborious calculation of a circular cylindrical shell roof is reduced to the calculation of a "model shell," whose principal features coincide with these of the given shell. Numerical tables are for the model shells given. 5. Shells with variable radius and variable thickness: This is an extension of the previous theory of circular shells. 6. Calculation methods for barrel roofs. 7. Reinforcement along trajectories; Calculation of girders. 8. Stability, annular and longitudinal moments. 9. The prestressed barrel roof. 10. Loads at the annular edge $x = 0$.

Each chapter opens with a historical review. Here reference is made to all important papers about shells in the world literature. Many numerically calculated examples of application are inserted in the text. The book also shows photos of several buildings calculated by the author. In this way, even the reader who is not a specialist can realize the practical value of the author's methods of calculation. E. Monch, Germany

Book—3816. Vol'mir, A. S., Flexible plates and shells (in Russian), Moscow, Gostekhizdat, 1956, 410 pp. + illus. 15r 20k; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13053.

This is a monograph devoted to nonlinear problems connected with large displacements of thin-walled plates and hollow shells. The first three chapters deal with flexible plates—the deduction of the basic equations, the investigation of bending under transverse loading and the work of compressed plates in the transcritical region. In chapter IV circular plates are examined with various forms of loading. Here also is included the problem of hollow axially symmetrical shells (flapping and flanged membranes).

Chapters V and VI embody general information regarding flexible shells and the solution of problems connected with large bending of cylindrical panels under transverse loading. In chapter VII the stability and transcritical deformation of cylindrical panels is looked into. Chapter VIII is given over to the stability of the fastened cylindrical shell. The problem is solved within the limits imposed for the application of the theory of hollow shells. In Chapter IX questions are examined of the local stability of a spherical shell, both in its linear as well as its nonlinear arrangement. Chapter X contains material of both general and particular interest and of debatable character of the nonlinear stability of shells in general. Chapter XI reviews the development of the theory of flexible plates and shells. When solving the problems in the book use is made of variational methods—the energy method of Bubnov-Galerkin [Collection from the work of S. P. Timoshenko, "On the stability of elastic systems." *Sb. In-ta Inzh. Putei Soobshch.* no. 13, 1913; "Selected works" Sudpromgiz, 1956, 136–139]. The book deals adequately with the contemporary position of the nonlinear theory of shells.

V. I. Feodos'ev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3817. Knowles, J. K., and Reissner, E., Note on stress-strain relations for thin elastic shells, *J. Math. Phys.* **37,** 3, 269–282, Oct. 1958.

Paper deals with shells for which the natural coordinate system does not coincide with the lines of curvature, e.g. helicoidal shells. Present work is an extension of authors' previous work [*J. Math. Phys.* **35,** 351–358, 1957; AMR **11** (1958), Rev. 808] to certain higher approximation theories. Arbitrary orthogonal, instead of oblique, coordinates are again used.

Authors show the higher approximation theories are adequate for rigid body displacements and also for rotationally symmetric states of strain in helicoidal shells.

G. D. Galletly, USA

3818. Houghton, D. S., The influence of frame pitch and stiffness on the stress distribution in pressurised cylinders, *Coll. Aero. Cranfield Note* 79, 11 pp. + 9 figs., Feb. 1958.

Author analyzes stress in pressurized circular cylinder reinforced by longitudinal stringers and transverse frames. (This simulates pressurized aircraft cabin structure). Numerous charts are given showing effect of frame pitch and stiffness on bending moments and hoop forces at various locations. Effects of varying frame pitch are illustrated by numerical examples. Possible advantages to be gained by using relatively closely-spaced frames are discussed.

A. M. Wahl, USA

3819. Ambartsumian, S. A., On a general theory of anisotropic shells, *J. Appl. Math. Mech. (Prikl. Math. Mekh.)* **22,** 2, 305-319, 1958. (Reprint order no. PMM 25, Pergamon Press, 122 E. 55th St., New York 22, N. Y.)

The shell is assumed to have only one plane of elastic symmetry parallel to the middle surface of the shell. Orthogonal curvilinear coordinates coinciding with the lines of principal curvature of the shell are employed. The usual assumptions of (1) normals to the middle surface prior to deformation remaining normal after deformation, as well as (2) neglect of stresses normal to the middle surface, are employed. Displacement components in the directions of the orthogonal coordinates are formulated as functions of the coordinate normal to the middle surface, with quadratic powers of this coordinate being retained. Expressions for the normal and shearing strains at a point located an arbitrary distance from the middle surface are then formulated. The six governing equilibrium equations are derived to constitute a complete set of equations for this shell theory. The particular case of a horizontal circular cylindrical shell, having simply supported ends and entirely filled with a liquid, is considered in detail.

W. A. Nash, USA

3820. Gruning, G., Calculation of circular cylindrical shells without using boundary value tables (in German), *Bauplanung u. Bautechnik* **11,** 7, 297–300, July 1957.

Author considers the problem of a portion of a circular cylindrical shell bounded by two horizontal generators and two circular arcs, loaded by its own weight and subject to various edge conditions. Approximate membrane and bending solutions are superposed; only first term in the Fourier expansion of each of these solutions is retained. A procedure, expected to have computational advantages over others commonly used, is described for the determination of the eight integration constants present in the bending solution. A similar procedure was used by Girkmann ["Flächentragwerke," Springer-Verlag, Vienna, 1954]. A numerical illustration is not included but is promised for the next issue of the same journal.

J. K. Knowles, USA

3821. Alumyae, N. A., Basic energy relations during deformation of thin-walled elastic shells (in Russian), Investigations on the question of stability and durability; Kiev, Akad. Nauk USSR, 1956, 70–74; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13033.

A formula is deduced for the virtual work of deformation of an elastic shell undergoing end displacement. It is assumed that the deformations are not small. The hypothesis on the character of the distribution of deformation along the thickness of the shell is not clearly brought in; however, it would seem that it was used in a concealed form when calculating the virtual work done. Assuming that the work of deformation depends only on the final states, author deduces relations which should satisfy the principles of elasticity in the theory of shells (analagous to Green's formulas in the general theory of elasticity).

A. L. Gol'denveizer

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3822. Zharmagambetov, B. S., Practical method for the calculation of a ferroconcrete spherical shell (of constant thickness) (in Russian), *Izv. Akad. Nauk KazSSR, Ser. Gorn. dela, Metallurgii i Obogashcheniya, Stroimaterialov* no. 8, 15–33, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11896.

Making use of the equation of symmetrical deformation of shells of rotation in Meissner's form [E. Meissner, *Phys. Z.* **14,** no. 8, 1914] and taking into consideration that at border loads the forces and deformation rapidly damp down, author replaces the solving hypergeometrical equation by a simplified equation of the Bessel type. Calculation formulas are derived for the forces and deformation when there is loading by border loads, in the form of moments and forces. The formulas obtained differ from those of other authors. An example of the calculations for a slanting spherical shell is given.

V. G. Rekach

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3823. Rekach, V. G., Symmetrical heating of inclined spherical shells (in Russian), *Sb. Trudi Mosk. Inzh.-stroit. In-ta* no. 8, 80–89, 1954; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11893.

A calculation is given for the temperature of a sloping spherical shell on the basis of the equations

$$\frac{1}{Eb}\nabla^4\varphi + \frac{1}{R}\nabla^2 W + \frac{2\alpha t}{Rb} = 0, \quad \nabla^2\chi = 0 \qquad [1]$$

$$\chi = D\nabla^2 W - \frac{1}{R}\varphi, \quad \nabla^2 = \frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r}$$

where φ is the stress function, W the bending function, D the deflection flexibility, t the temperature arising from irregular heating by the thickness. The solution of Eq. [1] is sought in the form

$$\varphi = D\nabla^4 \Phi(r), \quad W = \frac{1}{R}\nabla^2 \Phi(r);$$

and for the looked-for basic function $\Phi(r)$ the differential equation takes the form

$$\frac{D}{Eb}\nabla^4\psi + \frac{1}{R^2}\psi + \frac{2\alpha t}{Rb} = 0$$

where

$$\psi = \nabla^4 \Phi(r).$$

A. V. Sachenkov
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3824. Jensen, W. R., On simplified fuselage-structure stress distributions, *J. Aero/Space Sci.* **25,** 10, 656–657 (Readers' Forum), Oct. 1958.

To determine the stress distribution in a semimonocoque structure, the structure may be idealized by combining the stringers and skin into a smaller number of equivalent stringers. Author has investigated the minimum number of equivalent stringers required in an adequate idealization.

A four-bay cylindrical cantilevered shell without stringers subjected to a concentrated load at its free end was investigated analytically and the results compared with available test data. Analytical solutions were obtained for four assumed conditions: (1) simple beam theory for rigid structure, (2) longitudinal material continuously distributed around shell, (3) longitudinal material concentrated at six symmetrically placed locations at the skin line, and (4) longitudinal material concentrated at eight symmetrically placed locations at the skin line. For each analysis, the distribution of ring bending moment in each ring, longitudinal bending stress in the shell at each ring, and shear stress in the shell at each ring were computed. Results obtained by the continuously distributed, six-stringer, and eight-stringer analyses for ring bending moment and longitudinal bending stress were almost identical and showed excellent agreement with available test data. The idealized six-stringer and eight-stringer analyses predicted a stepwise distribution of the shear stress in the shell which was not in close agreement with the continuously distributed analysis or the test data, although the maximum shear stress predicted by all three of these methods was approximately equal. The simple beam theory was in poor agreement with the other analyses and test data.

Author concludes that for a structure of the proportions and loading considered a simplified idealized structure with a small number of equivalent stringers will give satisfactory design information.

W. K. Rey, USA

Buckling

3825. Johns, D. J., Optimum design of a multicell box subjected to a given bending moment and temperature distribution, *Coll. Aero. Cranfield Note* 82, 26 pp. + 4 tables + 9 figs., Apr. 1958.

Author presents a method for determining the optimum arrangement for skin thickness, web thickness and web spacing for a multicell box beam of given depth, to resist both applied bending stresses and thermal stresses. This is an extension of a paper by Houghton and Chan [*Coll. Aero. Cranfield Note* no. 74].

The design criterion for the box beam is based on the buckling stability of the compression skin. The proposed method involves an interative procedure. The method becomes quite simple when the skin thickness is specified initially, say, by stiffness requirement.

In the analysis, author assumes that the top and bottom skins are of the same thickness and hence the neutral axis is central. The latter assumption also applies when thermal stresses are applied to the beam. The temperature distributions are assumed symmetrical about the neutral axis. The elastic modulus of the material is assumed unaffected by the temperature variation due to kinetic heating.

T. H. H. Pian, USA

3826. Kraus, L., Integral equation of the buckling of a straight beam with thin open and double symmetrical profile (in German), *Ing.-Arch.* **26,** 1, 1-19, 1958.

In addition to detailed discussion of the title problem, author gives useful survey of integral equation formulation of general beam buckling problem.

C. E. Pearson, USA

3827. Shapovalov, L. A., The influence of non-uniform heating on the stability of a compressed bar, *J. Appl. Math. Mech.* (*Prikl. Math. Mekh.*) **22,** 1, 161-167, 1958. (Reprint order no. PPM 10, Pergamon Press, 122 E. 55th St., New York 22, N. Y.)

Considered is the stability of a clamped, compressed bar of rectangular cross section undergoing small, elastic-plastic deformations under conditions of nonuniform heating. The stress-strain characteristics of the material are arbitrary and the temperature field is assumed constant along the length of the bar and varying linearly across the cross section in the direction of lateral bending. For the assumed boundary conditions, the nonuniform heating does not cause initial bending of the bar. For the case of an ideally plastic material and also for a material with a linear strain hardening, results can be obtained in a closed form.

G. Gerard, USA

3828. Klement, R., Investigation of buckling of frame structures according to DIN 4114 Ri 10.2 with the help of Kani's relaxation method (in German), *Stahlbau* **26,** 12, 372-380, Dec. 1957.

DIN 4114 stability requirements provide formulas for buckling strength of frame members. These formulas are not applicable in the case of a simultaneous application of other types of load as well. In that case consideration of secondary effects becomes necessary. When stressing highly redundant structures, iteration methods, such as Hardy Cross or Kani, become imperative. The author shows how to apply the Kani method—in his opinion the more advantageous one—to this type of problem and illustrates it with several numerical examples.

J. Solvey, Australia

Vibrations of Solids

(See also Revs. 3732, 3749, 3876, 3884, 3904, 3905, 4043, 4163, 4193)

3829. Chubachi, T., Lateral vibration of axially moving wire or belt-form materials, *Bull. JSME* **1,** 1, 24-29, Jan. 1958.

Author analyzes the dynamics of a moving belt, including the effect of bending stiffness. The equation of motion is very similar to that for the vibration of a pipeline containing a moving fluid. Standard separation-of-variables techniques are used to obtain the characteristic equation, which is then solved by numerical iteration. Author shows that all modes of vibration become unstable at sufficiently high translational velocities; a number of charts illustrate these results. The problem is also solved approximately by using a truncated Fourier series representation of the normal modes.

T. K. Caughey, USA

3830. Barducci, I., and Pisent, G., Experimental investigation on the flexural natural frequencies of prismatic bars as a function of the thickness/length ratio (in English), *Acustica* **7**, 5, 288–292, 1957.

A series of prismatic bars of equal length, but different width, have been employed in order to investigate the dependence of their natural flexural frequencies on their width-to-length ratio.

Experimental results are compared with a mathematical theory developed by W. T. Thomson. From authors' summary

3831. Mar'yamova, F. A., New method for investigating the appearance of transverse vibrations of a rod (in Russian), *Sb. Trudl Mosk. Zoacbn. Poligr. In-ta* no. 5, 161–168, 1957; *Ref. Zb. Mekh.* no. 11, 1957, Rev. 13108.

Evaluation is carried out of the error occurring in Timoshenko's differential equations for deflection vibrations of a rod, built up when taking account of the inertia of rotation and the influence on bending of intersecting cross forces. Adopting N. A. Kil'chevskii's method [*Sb. Prats. In-ta Matem. Akad. Nauk URSR* no. 4, 1940], employed by this investigator for building equations of equilibrium for shells, author distributes the transposition of points on the rod in a series of steps of the coordinate (y) in whose direction transverse vibrations take place and which are retained in the resolution of members up to and including the third order. Constructing the corresponding resolution for stresses and reckoning that when $y = \pm h$ (h being the height of the rod's section) normal stresses set in and tangential stresses are absent, it is possible to obtain some links between the transpositions in the first and in the second approximations. The different variants of the final differential equations for transverse vibrations, one of which yields the Timoshenko equation, are obtained by evaluation of these links and the construction of equations for the plane-parallel motion of the rod's component. Preference should be given, in the author's view, to the equation representing the velocity of motion of the wave's front, coinciding with those velocities of propagation of disturbance in the elastic layer, which could be found by a strict solution of the equations for the theory of elasticity. Ya. S. Uflyand

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3832. Galustyan, S. B., Formulation of a generalized Green's function for the equation for the vibrations of a rod (in Azerb.), *Trudl Azerb. Industr. In-ta* no. 14, 85–106, 1956; *Ref. Zb. Mekh.* no. 10, 1957, Rev. 11949.

The sequential nature is shown of the formulation of a generalized Green's function for the equation

$$v^{IV} - \lambda\rho(x)v(x) = 0$$

for the case where $\lambda = 0$ is a simple or double natural value. A generalized Green's function is prepared in four particular cases of border conditions. V. V. Bolotin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3833. Melyakhovetskii, A. S., Integral equation for the oscillations of a curvilinear rod (in Russian), *Trudl Donetsk. Industr. In-ta* **20**, 27–39, 1957; *Ref. Zb. Mekh.* no. 11, 1957, Rev. 13110.

A general solution is put forward for the problem of the vibrations of a plane curvilinear rod of variable curvature and rigidity under the action of a load of arbitrary form in process of being disturbed and of a fluctuating load. Rods with elastically fastened ends are investigated. The deflection rigidity and the curvature of the rod change in accordance with principles describable by means of fragmentary smooth functions. The introduction of functions of influence for transpositions merges the problem with the system of integral-differential equations. The problem of determining the frequencies and amplitudes of the free vibrations of the rod leads to the determination of the natural numbers and the fundamental functions of a homogeneously loaded Fredholm integral equation of the second order with a symmetrical positive center and a monotonous function of distribution. The obtained solution permits the strict substantiation of the method of division of variables (Fourier's method) and of a number of approximation methods. A general solution for the problem of constrained vibrations is given. As a separate case, an investigation is made of the disturbed force, changing in accordance with sinusoidal principle.

Yu. P. Grigor'ev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3834. Edmonds, P. D., and Sittig, E., Experimental investigation of elastic eigen vibration of isotropic circular cylinders (in German), *Acustica* **7**, 5, 299–305, 1957.

An apparatus is described with the aid of which it is possible to measure the elastic resonances of cylindrical rods in the range 1 to 120 kc/s with an accuracy of about 1 in 10^{-5}. Azimuthal, radial and axial nodes can be recorded by their amplitudes on the sides of the rod, and hence the resonance can be ascribed to the different modes of vibration.

Data for an aluminum cylinder (24.0 × 4.9 cm) as to natural frequency, elastic constants and dimensions are compared with those proper to an infinitely long cylinder.

From authors' summary

3835. Petrovskii, A. V., A variant of Academician B. G. Galerkin's method (in Russian), *Trudl Dnepopetr. Khim. Tekhnol. In-ta* no. 4, 202–213, 1955; *Ref. Zb. Mekh.* no. 10, 1957, Rev. 11954.

This is a simplification of derivation of the Bubnov-Galerkin equations [*Vestn. Inzh.* no. 19, 1915] for the vibrations of a beam of variable section, loaded with concentrated forces and moments. As a preliminary operation a calculation is made for those determined integrals in which a concentrated load is present. In this way, the usual Bubnov-Galerkin equations are supplemented by terms, the pressure of which is due to the action of forces, having a "concentration" character. It should be noted that the variant of the Bubnov-Galerkin method put forward by the author appears to be inherent, as the consequence of its basic variant.

A. V. Sachenkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3836. Kellenberger, W., Bending vibration of a noncircular rotary shaft in horizontal position (in German), *Ing.-Arch.* **26**, 4, 302–318, Aug. 1958.

The bending stiffness of a shaft is the same along its length, but different for the two principal directions of its cross section. The latter rotates uniformly about one of its points that does not coincide with its mass-center. Moving orthogonal axes are chosen in it and the equations of motion deduced taking into account the centripetal and Coriolis forces. The three partial differential equations reduce to two after some simplifications, z and t being the variables on which the two displacements u, v in the principal directions depend. Author considers first the case of free oscillations (neglecting for the moment eccentricity and gravity) and solves the homogeneous equations by the separation method. After introducing the boundary values at the ends of the shaft, a pair of ordinary differential equations of the second order for $u(t)$ and $v(t)$ are found, and the discussion of this system is the main part of the paper (frequencies, stability). Then eccentricity and gravity are considered, which appear in the right-hand member of the equations; the particular solutions are given as a Fourier series. O. Bottema, Holland

3837. Onoe, M., Contour vibrations of thin rectangular plates, *J. Acoust. Soc. Amer.* **30,** 12, 1159–1162, Dec. 1958.

Frequencies for extensional modes are determined for their rectangular plates of ADP (ammonium dihydrogen phosphate) Z-45° cuts as a function of length-to-thickness ratios for values up to five. Method of analysis uses functions which satisfy the differential equations and all boundary conditions except for two free edges. The work done by the residual stresses on the nominally free edges is made as small as possible for a good approximation.

Good correlation is obtained between analytical and test values. A mode heretofore obtained only for square plates is determined for the range of length-to-thickness ratios.

M. V. Barton, USA

3838. Yeh, G. C. K., and Martinek, J., Forced vibration of a visco-elastic rectangular plate in fluid media (in English), 9th Congrès Intern. Mécan. Appl., Bruxelles Univ. 1957; **5,** 352–359.

Equations, assumptions, range of applicability and general description of this problem as in AMR **12** (1958), Rev. 114. Authors extend investigation to clamped plate. Characteristic functions previously employed for simply supported plate are no longer suitable. System of simultaneous equations is employed to obtain solutions of generalized co-ordinates. Plate deflection and energy transmission co-efficient are thus obtained.

V. A. Valey, USA

3839. Yu, Y.-Y., Vibrations of thin cylindrical shells analyzed by means of Donnell-type equations, *J. Aero/Space Sci.* **25,** 11, 699–715, Nov. 1958.

Author discusses title problem and gives solution for non-axially symmetric vibrations. He gives numerical values for phase velocity, mode shape and frequency for wide range of wavelengths for $M = 2$. Results with and without shear and rotating inertia terms are shown. Major point of interest is use of Galerkin method to give frequencies of finite tubes with various end conditions.

R. Plunkett, USA

3840. Geiger, J., Vibration calculations for industrial buildings (in German), *Beton u. Stahlbeton.* **52,** 10, 243–249, Oct. 1957.

Prestressed concrete panels used as machine foundations are considered. Natural frequencies of these panels are calculated by elementary methods and verified by measurements.

H. Schaefer, Germany

3841. Borbely, G., Block foundation for crank machines (in Hungarian), *Mélyépitéstudományi Szemle* **8,** 7, 333–336, July 1958.

Author shows that, in practice, where, in general, $\omega/\omega_0 < 1$, making the base surface larger, the natural frequency of engine foundations cannot be affected effectively. For block foundations, the use of vibration isolation (cork cushion) should be avoided; it does not reduce the magnification factor.

A. Kezdi, Hungary

Book—3842. Terskikh, V. P., Calculations for torsional vibrations of power plants (A manual), Vol. I (in Russian), Moscow-Leningrad, Nauch.-tekhn. Izd-vo Mashino-str. i Sudostroit. Lit., 1953, 259 pp., bound app. 83 pp., 28r 40k; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11960.

Methods are presented for classifying torsional-vibratory systems, ways for determining amplitudes of the exciting moments and for calculating form and frequencies of natural torsional vibrations. In the first part, author gives the procedure for bringing the power plant into the calculations scheme, consisting of concentrated masses connected by inertialess elastic elements. The formulas, curves and nomograms, given in the appendices, make it a very simple matter to determine the moments of inertia and the elastic characteristics of the different elements comprised in the power unit. Evaluation of the nonlinear properties of the system is recommended to be done by the linearization method. A detailed examination is carried out of the various forms of linear and nonlinear friction and the relation is given between the vibration amplitude and the work of friction, to cover one operative cycle. The sequential nature of bringing the system into the calculation scheme is demonstrated by an example of a ship's assembly.

The second part contains formulas and tables for the determination of moments giving rise to torsional vibrations. A few methods are given for the harmonic analysis of the curves of excitation. The appendix does not give a table for the functions $\sin k\alpha$, $\cos k\alpha$ ($k = 1, 2, 3, \ldots$), which are often required in harmonic analysis. In the third part, a calculation method is demonstrated for the frequencies and for the form of torsional vibrations in conformity with the method of chain fractions. Different forms of the systems are examined, such systems being met with in machine and ship construction: simple, branched, ring-shaped, complex, etc. Methods are shown to reduce the length of the calculations by utilizing the full or the partial symmetry in the system. Approximate methods are also put forward for the evaluation of the nonlinear properties of a system in cases where one or two nonlinear components are present. In the appendix nomograms are given for the determination of the frequencies of torsional vibration systems from groups of equal mass with one or two auxiliary masses. The methods of calculation given in the book are illustrated by a large number of examples.

M. L. Kempner

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—3843. Terskikh, V. P., Calculations for the torsional vibrations of power units (A manual), Vol. II (in Russian), Moscow-Leningrad, Gos. Nauch.-tekhn. Iz-vo Mashino-str. i Sudostroit. Lit., 1954, 215 pp., bound app., 29 pp. 19r 95k; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11961.

Methods are demonstrated for calculating resonant vibrations with consideration for various forms of friction, for calculating non-resonant constrained vibrations with and without taking friction into account. In the fourth part, methods are given for the computation of the frequencies and form of vibration when resonance is present, with the determination of the dangerous stresses in portions of the shaft. The amplitudes and stresses of resonant vibrations are determined from the condition of the equality of the work of the exciting forces and the forces of friction. It is shown that when evaluating the magnitude of the work of the friction forces the error may be one of the order of 50-100%. Indicative also is the magnitude of the permissible dynamic stress, which, for carbon steel, author recommends should be taken as equal to $r = 300$–400 kg/cm^2.

As examples of linear systems without friction, examinations were made of: simple systems with and without a reductor, branched and ring systems, systems with multicylinder power units. When putting forward calculations for systems with friction, author specially differentiates the case where the specific resistance in the system is greater than 0.5. Such systems he designates conditionally as systems with "large friction." The character of constrained vibrations where large friction is operating is markedly different from the character of constrained vibrations in systems with small or zero-value friction. The maximum amplitude may not correspond to, and may show great divergence from, the frequency value of natural vibrations; the form of vibration in the presence of resonance may not coincide with the corresponding form calculated without consideration of the friction. A calculation is given for the system with large friction on the example of a two-mass system. The procedural method of calculating, worked out by the author, is put forward, in the majority of cases, in the form of tables. Supplementary curves, nomograms,

and also data regarding the mechanical properties of various materials are given in the appendix. M. L. Kempner

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—3844. Terskikh, V. P., Calculations for torsional vibrations of power units (A manual), Vol. III (in Russian), Leningrad, Sudpromgiz, 1954, 200 pp. + illus. 13r 15k; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11962.

Descriptions are given of the experimental methods employed in investigations of torsional vibrations and the counter measures used to deal with such vibrations. In the seventh part, apparatus is described which is used for measuring of torsional vibrations: Geiger's torsiograph, D FL, by Popov, amplitudometer, electrotorsiograph, wire strain gages and apparatus working on different systems. The most detailed description is given of the process of recording torsion with the Geiger instrument; a preliminary analysis of the records is furnished, while taking into account possible distortions due to the belt drive and to the torsiograph itself. It is recommended that a detailed analysis should be carried out graphically by utilizing a special scheme and tables, published in the appendix to the manual. Torsion measurement with the use of wire strain gages, a method which has wide application in machinery building, is examined in a very schematic way. In the eighth part, methods for taking countermeasures for cases of dangerous resonant torsional vibrations are gone into. As examples of these measures the following are recommended: varying the component elements of the motor, varying the sequence of the ignition, setting up vibration dampers.

Author introduces a special classification, dividing dampers into antivibrators and actual dampers. To the first class he relegates dampers which only alter the frequency characteristic of the system; to the second he allots dampers which partially absorb the energy of vibration. A linear antivibrator (known under the name of the dynamic damper), a nonlinear antivibrator (the elastic characteristic of which approximates to two sections from the straight), and different forms of pendulums for antivibrators are examined. It is recommended that the parameter and construction of an antivibrator should be selected on the basis of analysis of the frequency characteristics of the whole system and on the possible dangerous resonances from different harmonics of the exciting forces. It is noted that at large amplitudes of the swing of the pendulum the vibration equation becomes nonlinear. For this case formulas are given in which the product of the swing amplitude and the equivalent moment of inertia of the hub of the antivibrator is expressed through a Bessel function. An exposition is given of the theory of a linear damper with an elastic bond and without it, of a damper with constant specific resistance, of a damper with constant friction with an elastic bond and without it, of a mercury damper, etc.

Recommendations are made regarding the selection of the parameters of all the afore-mentioned dampers. The methods of calculation of torsional vibration systems with dampers and antivibrators do not differ in principle from the methods of calculation of systems without antivibrators, which were gone into in the first two volumes of the manual. The additional tables contained in the appendix reduced the calculation work to a minimum. The technicalities of calculation are thoroughly illustrated in four examples. M. L. Kempner

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3845. Reissner, E., and Washizu, K., On torsional vibrations of a beam with a small amount of pretwist, *J. Japan Soc. Aero. Engng.* **5,** 47, 330–335, Dec. 1957.

Present paper treats the problem of the pretwisted, narrow cross-section beam on the basis of an approximate system of differential equations which is obtained by variational methods from the theory of shallow thin shells.

Application of the equations of the paper to the problem of torsional vibrations shows that a relatively small amount of pretwist may have a considerable influence on the torsional frequencies of the beam.

From authors' summary by P. M. Naghdi, USA

Book—3846. Brennan, J. N., editor, Bibliography on shock and shock excited vibrations, Vol. I (Engng. Res. Bull. 68), University Park, Pa., Pennsylvania State Univ., 1957, vi + 348 pp. $2.

This bibliography contains abstracts of 1168 technical papers on shock and shock-excited vibrations. Information is included on theoretical and analytical methods, experimental methods and equipment, measurement and instruments, properties of materials, characteristics of structures, isolation and packaging, and miscellaneous. Also included are summaries of the abstracts on (1) Mathematical methods for investigating dynamic behavior of structures subjected to impulsive forces, (2) The shock spectrum approach to impact problems, (3) Behavior of materials under impulsive loading, (4) Dynamic behavior of structures under impulsive loading, (5) Impact testing devices, and (6) Instrumentation for measuring impulse forces and motions. An author index, a subject index and the details of the scope of the search may be found in the appendix. The abstracts are mainly of papers published in technical journals from 1938 to 1955.

From author's summary

Book—3847. Brennan, J. N., editor, Bibliography on shock and shock excited vibrations, Vol. II, (Engng. Res. Bull. 69), University Park, Pa., Pennsylvania State Univ., 1958, x + 181 pp. $2.

Part 1 of this bibliography contains abstracts of 415 technical papers on shock and shock-excited vibration mainly from journals of technical societies. Part 2 includes references to 537 documents on shock and shock-excited vibrations available to qualified users through ASTIA. Author and subject indexes for Volumes I and II combined is included in a pocket inside the back cover.

From author's summary

3848. Mains, R. M., Minimizing damage from random vibration, *J. Acoust. Soc. Amer.* **30,** 12, 1127–1129, Dec. 1958.

Damage is defined and examples are cited. Illustrative problems of relay contact arm chatter, gyro precession and noise generation, and stress fatigue are given. It is concluded that there are three means by which damage can be reduced: raising the damage threshold of the item, modifying the transmissibility of the intervening structure, or reducing the severity of the excitation. The examples are an attempt to show specifically how this can be done in practical cases. From author's summary

3849. Meyer, E., Brendel, K., and Tamm, K., Pulsation oscillations of cavities in rubber, *J. Acoust. Soc. Amer.* **30,** 12, 1116–1124, Dec. 1958.

The oscillation behavior of a spherical cavity in an infinite elastic medium is calculated for the case of an incident spherical dilatational wave entirely reflected at the cavity walls. It is shown that there exists for every Poisson's constant $0 \leq \sigma \leq 0.5$ a frequency for which the amplitude of the oscillating cavity walls becomes a maximum. It is also shown that the amplitude resonance curves are symmetrical and that, assuming loss-free material, they have a finite half-width, which is caused by radiation losses and depends only on the ratio of shear wave and dilatational wave velocity.

Pulsation oscillations of spherical, rotational-elliptical, cylindrical, and cubic cavities in rubber blocks were examined experimentally. The pulsation oscillations were excited by means of

a sound source coupled to the surface of the rubber block. The sound pressure inside the cavities was measured with a probe microphone. The experimental results for spherical cavities are compared with the theory. Good agreement is found with respect to the resonance frequencies. From authors' summary

3850. Weidenhammer, F., Deviation of mean position in vibration-measuring instruments (in German), *Ing.-Arch.* **26,** 1, 43–60, 1958.

The instruments considered possess a pendulum rotating about a horizontal axis and kept in a horizontal equilibrium position by the aid of a spring. The investigation is concerned with determining the mean positions of the pendulum as well as the motion about it when the instrument is subjected to a periodic forced vibration in an arbitrary direction perpendicular to the axis of rotation of the pendulum. This problem is determined by a nonlinear differential equation of the second order, nonlinear terms being due to gravity and to the perturbating force.

The equation is transformed by a Fourier time series for the displacement angle of the pendulum into an infinite set of nonlinear equations. This set is solved by expanding all terms in power series to a small parameter ϵ denoting the ratio of the perturbating amplitude to the reduced length of the pendulum and assuming that the perturbation frequency is so high that the ratio of the natural frequency to the perturbation frequency is also of order ϵ. The constant term in the Fourier series, determining the mean position of the pendulum, follows from a transcendental equation. It appears that there is more than one mean position possible and, subsequently, the stability of the different mean positions is investigated. Some are found to be stable, others are unstable.

A number of valuable conclusions for design have been drawn from the numerical calculations performed. It is shown that a small error in spring stiffness, so that the mean position of the pendulum even without external perturbation is not horizontal, affects greatly the behavior of the instrument under perturbation. It may then be that the mean position near the horizontal becomes unstable, making the practical utility of the instrument doubtful. A downward deviation is preferable to an upward one.

Experiments have been performed which confirm the theoretical results. A. I. van de Vooren, Holland

3851. Carnegie, W., Dynamically isolated vibration test rig, *Engineering* **187,** 4844, 54–55, Jan. 1959.

Cantilever is fixed to block on spring. Author shows that frequencies of cantilever are close to those of fixed cantilever if block mass $\gg$ beam mass and block frequency $\ll$ beam frequency. Torsional frequencies are also considered.

R. N. Arnold, Scotland

3852. Sumner, G., and Entwistle, K. M., The measurement of the strain-dependent damping of metals vibrating torsionally, *Brit. J. Appl. Phys.* **9,** 11, 434–438, Nov. 1958.

Apparatus is described for the measurement at room temperature of the mechanical damping of torsionally vibrating metal specimens up to shear strains of about 2×10^{-3} for mild steel. Vibrations are maintained by a moving-coil exciter which is energized by an electronic feedback circuit and controlled by a Rochelle salt detector coupled to the end of the specimen. The phase of the exciter current is adjusted to coincide with that of the angular velocity of the specimen so that absolute values of energy loss can be obtained by measuring the exciter current, the exciter force constant and the frequency and amplitude of vibration. Values so obtained for an aluminum alloy agree with the decrement measured by a free-decay test to about 1%. Evidence is reported which shows that such agreement would not be expected with ferromagnetic specimens because the free-decay tests do not allow enough time for a cyclic condition to be attained at intermediate strains. The total extraneous energy loss in the apparatus is shown to be less than 3×10^{-5} of the vibrational energy of the system.

From authors' summary

Wave Motion and Impact in Solids

(See also Revs. 3802, 3846, 3847, 3895, 3897, 4181)

3853. Leonard, R. W., On solutions for the transient response of beams, *NACA TN* 4244, 49 pp. + 2 tables + 9 figs., June 1958.

Author applies eigenvalue theory as modified by Williams to title problem and considers a free-free beam with a concentrated mass at its center, a cantilever beam, and a simple supported beam. Solutions are based on the elementary and Timoshenko beam theories. The second part of the paper contains a critical discussion of the traveling-wave method and a numerical integration method. Numerical results of both procedures are compared with results of the eigenvalue theory.

M. Kuipers, Holland

3854. Yonezawa, H., On the plastic deformations of beams due to impact loading (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 58, 23–29, Sept. 1958.

Paper discusses the plastic deformations of cantilevers under "blast-type" loading The deformations are divided into four classes according to the position or to the intensity of the load.

The equations of motion for the deformations of each of the four classes and the solutions of these equations are introduced under the assumption of negligible elastic strain and of "plastic-rigid" behavior. As the result of analysis, approximate final permanent deformations are obtained. From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

3855. Davids, N., and Kumar, S., Cylindrical stress waves in flat slabs, *Quart. J. Mech. Appl. Math.* **10,** 4, 465–481, Nov. 1957.

Paper presents an elastic analysis of stress-wave propagation in an infinite slab of arbitrary thickness for the radially symmetric modes under suitable line-source excitations. Theoretical curves of both the nondimensional phase and group velocities are given for Poisson's ratio from zero to half. Curves which refer to infinite steel plates (Poisson's ratio = 0.29) are shown to be in good agreement with experimental data for finite circular disks of barium titanate (Poisson's ratio = 0.3).

G. S. Verma, USA

3856. Viktorov, I. A., Rayleigh-type waves on a cylindrical surface, *Soviet Phys.-Acoustics* **4,** 2, 131–136, Dec. 1958. (Translation of *Akust. Zh.* 4, 2, 131–136, Apr.–June 1958 by Amer. Inst. Phys., New York, N. Y.)

Author discusses Rayleigh-type waves propagating along a cylindrical surface in a direction normal to the axis. The case of both convex and concave surfaces is considered. In the latter, the author arrives at a complex wave number which he, erroneously, attributes to damping connected with radial emission of energy. H. Deresiewicz, USA

3857. Molotkov, I. A., The propagation and diffraction of the nonstationary waves in a two-layer medium with a cylindrical boundary of separation (in Russian), *Vestnik Leningrad Univ.* no. 16, 51–64, 1958.

Article deals with the problem of the plane nonstationary wave propagation in two media divided by the surface of an infinite circular cylinder. The quickly changing part of the solution is picked out from the whole expression represented by the Fourier series with radial functions in the form of Mellin's integrals. The radial functions are investigated and evaluated by the method of

steepest descent. Expressions describing the wave field near the front and in the region of geometrical shade are obtained.

From author's summary

3858. Ogurtsov, K. I., Uspenskii, I. N., and Ermilova, N. I., Some quantitative investigations regarding the propagation of waves in the most simple elastic media (in Russian), Questions relating to the dynamic theory of propagation of seismic waves. I, Leningrad, Gostoptekhizdat, 1957, 296-365; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13091.

An investigation is carried out of the disturbance field near the wave front aroused in an unbounded elastic medium or in an elastic semi-space by different types of sources. Results are given of the calculations for the intensity of the waves for a number of correlations of the elastic parameters of the medium. The data of the calculations show that the relation of intensity of the transverse and longitudinal waves is inversely proportional to the relation of velocities of these waves, while the relative intensity of the conical waves (by comparison with the longitudinal and transverse waves) increases with the increase of the velocities' relation. Interchange waves of types PS or SP, reflected from the free surface, always appear to be less intensive by comparison with waves of no change.

A. V. Manukhov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3859. Alekseev, A. S., and Tsepelev, N. V., Intensity of reflected waves in a laminar-heterogeneous elastic medium (in Russian), *Izv. Akad. Nauk SSSR, Ser. Geofiz.* no. 9, 1021-1035, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13094.

The known radial method for the calculation of the intensity of wave fronts is made use of for the problems of reflection of elastic waves. This method permits the finding of the intensity of wave fronts if the rays are known (the equations for which can be found with the aid of Fermats' principle). Knowledge of the precise solutions of the corresponding problems is not essential. To start with, there is a general discussion of the application of the ray method to problems on the reflection of elastic waves. Then a case is examined, important from the point of view of application, of heterogeneity, dependent on a single coordinate. In this particular case of linear change of velocity of elastic waves with depth, the formulas are taken up to a numerical value. In supplements to the paper, so-called characteristics of the directive capacity of some sources of elastic waves are brought in and also the coefficients of breaking and reflection when elastic waves fall on the boundary of two media.

V. M. Babich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3860. Sidlyar, M. M., Dynamic-elastic disturbances in a circular ring (in Russian), *Nauch. Zap. Kievsk. In-ta* **13**, 8, 133-147, 1954; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 13097.

The plane dynamic problem is examined of a circular ring under the action of variable-by-time radial forces, evenly distributed along the outer and inner contours. The forces are applied suddenly. In the first moment of time the ring remains in a state of rest. The disturbances sought, u, appear as functions of radius r and time t and must satisfy the equation

$$\frac{\partial^2 u}{\partial r^2} + \frac{1}{r}\frac{\partial u}{\partial r} - \frac{u}{r^2} = \frac{1}{c^2}\frac{\partial^2 u}{\partial t^2}$$

with original conditions

$$[u]_{t=0} = \left[\frac{\partial u}{\partial t}\right]_{t=0} = 0$$

and boundary conditions

$$[\sigma_r]_{r=r_1} = R_1(t), \qquad [\sigma_r]_{r=r_2} = R_2(t)$$

where σ_r are the radial stresses. By applying the one-sided Laplace transformation the equation and boundary conditions are transferred to the virtual region. Bessel's equation is obtained, the general integral for which is recorded through two cylindrical functions of imaginary argument. This solution obeys the transformed boundary conditions. With the aid of the conversion formula, transition is made to the original region. The disturbances sought for the general case are presented in the form of a Ryman-Mellin integral. An investigation is carried out of the roots of the denominator of the sub-integral function in a complex region. It is shown that the denominator only has a prime number of imaginary roots. By means of transfer to the asymptotic resolutions of Bessel functions a simple approximate formula is obtained for the large values of the roots according to the modulus. A table is constructed for the first ten roots of the denominator for a plane strain and for a plane stressed condition, taking different values for the relation r_2/r_1. The case is examined in more detail where the external and internal pressures, applied suddenly, ultimately remain constant. For this case the Ryman-Mellin integral is computed with the aid of the theory of deductions, and the disturbances are presented in the form of an infinite series. The uniform convergence of the series obtained is substantiated.

L. M. Kurshin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3861. Utagawa, M., Dynamic loads on spur gear teeth, *Bull. JSME* **1**, 4, 397-403, Nov. 1958.

Bending stress in tooth was measured as it passed through mesh. Stress was also calculated by measuring tooth errors and treating pair of wheels as a single-freedom linear damped system. Agreement with experiment is good. Work is restricted to 30 m/sec pitch line velocity and below.

D. C. Johnson, England

3862. Hashikura, K., Sugimoto, T., Kuriyama, H., and Sakurai, H., On the operating condition of automobile shock absorber, *J. Mech. Lab. Japan* **4**, 1, 28-34, 1958.

Authors tried to measure a frequency of relative velocity (V_{rel}) between the axle and the car body under various road conditions. A car body acceleration frequency was measured on a car suspension with various types of shock absorbers.

From authors' summary

3863. Murphy, H. L., Blast loading on structures, *Proc. Amer. Soc. Civ. Engrs.* **84**, ST 7 (*J. Struct. Div.*), Pap. 1837, 11 pp., Nov. 1958.

An introductory discussion of blast loading on structures is presented in terms of nuclear blast phenomena and as related to closed rectangular structures above ground, semi-buried, and underground.

From author's summary

3864. Anderson, F. E., Jr., Blast phenomena from a nuclear burst, *Proc. Amer. Soc. Civ. Engrs.* **84**, ST 7, (*J. Struct. Div.*), Pap. 1836, 7 pp., Nov. 1958.

Paper describes briefly the air blast and ground shock free field phenomena associated with a nuclear burst. The data presented extend those presented in the publication "The effects of nuclear weapons." This information is intended to aid the engineer responsible for the design of blast-resistant structures.

From author's summary

3865. Kollar, L., Girder design for striking load (in Hungarian), *Mélyépitéstudományi Szemle* **8**, 8/9, 402-408, Aug./Sept. 1958.

The Hungarian Standard specifications concerning the design of funicular railway contain a few practical rules for the stress

analysis of such a beam which will be loaded by a striking mass. The author attempts to justify these rules. For this purpose, the well-known theorems and usual approximations of the theory of impact are applied, and the approximations are criticized. A numerical example supplements the treatment.

J. Barta, Hungary

Soil Mechanics: Fundamental

(See also Revs. 4093, 4094, 4222)

Book—3866. Akroyd, T. N. W., Laboratory testing in soil engineering, London, G. T. Foulis & Co., Ltd., 1958, xx + 233 pp. 50 s.

This book is an excellent collection of common procedures in the Soil Mechanics Laboratory. The clear description of practical methods for elimination of common faults in testing and the examples of calculations make the book very valuable for laboratory personnel. The preparation of samples, moisture content size analysis, shear -, consolidation -, permeability -, California bearing ratio -, and soil stabilization tests are described in great detail. Nomenclature of soil mechanics is given. Equipment needed in laboratories is listed. The numerous photographs showing proper testing procedures and apparatuses, etc., are remarkable. This book is one of the most indispensable tools of the soils engineer and technician.

A. L. Simon, USA

3867. Hanamoto, B., Artificial soils for laboratory studies in land locomotion, U. S. Army Ordnance Corps, OTAC Rep. 20, 19 pp. + 10 figs., Nov. 1957.

The three types of artificial soils produced and tested in the Land Locomotion Research Laboratory have shown the necessary stability of mechanical properties and great ease in handling over the wide range of values.

The data indicate a feasibility of producing artificial soils of any desired properties by using bentonite, sand and glycol, which eliminates the necessity of using unstable and uncontrollable natural soils, and simplifies laboratory work.

From author's summary

3868. Gorbunov-Posadov, M. I., and Sinelschikov, S. I., Determination of the deformation modulus by means of the simplest soil characteristics (in Russian), *Osnovania i Fundamenty* no. 21, 17-23, 1958.

By analyzing 437 soil samples, authors establish by statistical method the correlations between the compressibility coefficient on one hand and viscosity and plasticity characteristics on the other. Results obtained may indicate values for the deformation modulus of soils, function of the porosity and plasticity coefficents.

R. J. Bally, Roumania

3869. Kezdi, A., Contributions for calculations of stress distribution in the ground (in German), *Bauingenieur* **33,** 2, 54-58, Feb. 1958.

Paper gives formulas and graphs for the stress distribution in the ground for the following cases: (1) Uniform load on a circular plate and a continuous footing at various foundation depths (semi-infinite elastic solid loaded at a certain depth below the surface; (2) uniform load on a circular plate founded on a relatively stiff stratum (mod. E_1) over a less stiff layer (mod. E_2). The upper layer is transformed into an equivalent layer of modulus E_1. Theoretically, author's method for a cohesionless base course is not satisfactory because the modulus E_1 is not defined for such layer; (3) Influence of the shear stresses between the foundation and the ground. Method is based upon an unjustified assumption about the magnitude of the shear stresses.

H. Lundgren, Denmark

3870. Mori, A., Significance of thixotropy in bearing value of compacted clayey subgrade (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 57, 7-11, July 1958.

The reduction in strength of clayey subgrade soils under pavement was observed when the subgrade soil was remolded at the equal water content. This result means that the strength of compacted clayey subgrade increases with time, a result due to thixotropy of soil. The thixotropic effect should be considered when strength of subgrade or specimen immediately after compacting is used for deciding the design strength of the clayey soil. This paper deals with the increment of strength on remolded clayey soil for determination of design strength.

From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

3871. Sharov, V. S., Clay as a soluble monolithic rock and the soil cohesion (in Russian), *Osnovania i Fundamenty* no. 21, 23-29, 1958.

Treatment of clay as a water soluble macromolecular body is suggested. In the presence of water the clay separates into macroanions environed by changeable cations taken down from the surface of clay particles with water molecules oriented round them. Proceeding from this idea, the water absorption by clay is explained as an osmotic phenomenon; mechanism of the strong cohesion of wetted and then dried clays is analyzed, when it is considered as a molecular cohesion, and a law is given for the electro-osmotic water movement through the soil.

R. J. Bally, Roumania

3872. Kuz'minov, M. P., An approximate method for calculations of the consolidation of alluvial soil structures (in Russian), *In-ta Sooruzh. Akad. Nauk UzSSR* no. 7, 217-223, 1955; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 12034.

Approximate methods are put forward for the solutions of equations for the theory of consolidation of earth masses for both the linear and plane problems, based on the application of the method of finite differences, with the introduction of one or two simplifying assumptions. In the numerical examples given it was shown that author's method produced results near to those obtained by V. A. Florin ["Theory of consolidation of earth masses." Moscow, Stroiizdat, 1948, p. 123] and N. A. Zadubin [*Izv. Vses. N.-T. In-ta Gidrotekhn.* **43,** 1950]

V. G. Berezantsev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3873. Roscoe, K. H., Schofield, A. N., and Wroth, C. P., On the yielding of soils, *Géotechnique, Lond.* **8,** 1, 22-53, Mar. 1958.

Hvorslev's equation for the shear strength of clay is shown to define a surface in a space of three variables σ', e and τ. The progressive yielding of a sample defines a loading path in this space, and the paths taken by samples in differing tests can be correlated if a boundary energy correction is applied. The final portions of all paths then lie in a unique surface, and the paths end at a unique critical voids ratio line. At the critical voids ratio state unlimited deformation can take place while σ', e and τ remain constant.

The two concepts of the existence of such a surface and such a critical voids ratio line are verified by an analysis of results of triaxial tests on a clay. Similar tests on silt and sand also confirm the concepts, although some inaccuracy is inherent in these tests. Finally, results of tests on granular media in a simple shear apparatus are presented which confirm closely the applicability of both concepts to the yielding of granular media.

From author's summary

Soil Mechanics: Applied

(See also Rev. 3840)

3874. Bardoczy, L., Strength computation of cutting edge of circular sink wells (in Hungarian), *Mélyépítéstudományi Szemle* **8,** 202–208, Apr./May 1958.

Methods available for this problem are mainly rough approximations; after a criticism of them, author proposes a more correct solution. Neglecting the effect of earth pressure along the edge and the variations in the thickness of the mantle and taking an infinitely long cylinder, he then deduces formulas for the horizontal and vertical component of the force acting on the inside surface of the edge. He writes down the forces acting along the rim of the sink well and determines—using the formulas of Belluzzi—the moments and shear forces in the mantle. Tables and numerical examples make the use of the method easy.

A. Kezdi, Hungary

3875. Rozsa, L., Elastic foundation problems of tunnel lining (in Hungarian), *Mélyépítestudományi Szemle* **8,** 4/5, 193–198, Apr./May 1958.

3876. Shekter, O. J., On the calculation of a craneless vibrator (in Russian), *Osnovania i Fundamenty* no. 21, 7–11, 1958.

A theoretical method for calculating the motion of a vertically oscillating annular vibrator used for driving piles in the ground. Vibrator is mounted at the upper end of the pile and is fitted with an automatic device for clamping it.

R.-J. Bally, Roumania

3877. Jandy, G., Earthwork design for terrain correction (in Hungarian), *Mélyépitestudományi Szemle* **8,** 7, 311–319, July 1958.

Processing of Metals and Other Materials

(See also Revs. 3762, 3764, 3767, 4225)

Book—3878. Howard, E. D., edited by, Modern foundry practice, 3rd ed., New York, Philosophical Library, 1959, 464 pp. $15.

This guide to British foundry work is a handbook for apprentices, students, craftsmen and executives in the industry, and for others wishing to obtain an understanding of its techniques. Each chapter has been written by a specialist and provides a self-contained and intensely practical treatment of its subject. The style has been made as simple and straightforward as possible, and the text is fully illustrated by several hundred realistic drawings as well as photographs, so that even the beginner with only a slight knowledge of foundry operations will find the whole book readily understandable.

The text for this third edition has been thoroughly revised and enlarged, to keep pace with progress in the industry.

From author's preface

3879. Kneschke, A., Hydrodynamic theory of hot rolling (in German), *Arch. Eisenhüttenw.* **29,** 1, 11–22, Jan.. 1958.

The hot-rolling of strip of large width is analyzed theoretically on the assumption that the resultant stress distribution is the sum of (a) a constant compressive stress k_f acting between the rolls normal to the plane of the strip, and (b) a hydrodynamic pressure p and shear stress r generated within the strip by the motion of the rolls, the strip material being treated for this purpose as a Newtonian fluid to which Reynolds equation for viscous motion in thin films can be applied.

Expressions are derived for the variation of p and for the resultant forces and the resisting moments on the rolls. As further consequences of the initial assumptions it is shown that a reduction of strip thickness in excess of 74% implies reversed flow at inlet, and that, for certain combinations of reduction and initial strip thickness, the one positive principal stress will exceed any specified value at exit, and under less severe restrictions at inlet.

Adverse criticism of the basic assumptions, by H. G. Muller and with which the reviewer largely agrees, is appended, together with a reply by the author in which he quotes experimental results due to Strandell and Leufven in confirmation of the theoretical predictions concerning total roll force.

G. D. S. MacLellan, England

3880. Beresnev, B. I., Vereshchagin, L. F., and Ryabinin, Yu. N., On pecularities of rheological behavior of metals extruded by liquid pressure (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 5, 48–55, May 1957.

Description of hydrostatic extrusion experiments on Al and Cu at moderate reductions (80 and 50% respectively) and pressures (120 kips). Liquid was supplied to a small thick-walled vessel from a high-pressure pump. Both reductions and die angles were varied and minimum extrusion pressure was found at a die semi-angle of 25–30° as compared with the much larger optimum angles for conventional, nonhydraulic cold extrusion.

Evaluation of several primitive extrusion theories showed that none is satisfactory or reliable.

N. H. Polakowski, USA

3881. Lueg, W., and Funke, P., Jr., Study on the drawing of titanium bars as an example for the deformability of materials difficult to work (in German), *Stahl u. Eisen* **78,** 25, 1816–1822, Dec. 1958.

Literature on the drawing of titanium is cited. Authors describe their own tests: drawing process and surface finish of the products to be drawn. Drawing load and calculation of the friction coefficient. Determination of the swelling in drawing. Results of the metallographic examination of the cold-worked structure. Hardness distribution.

From authors' summary

3882. Buhler, H., and Altmeyer, G., The influence of redrawing and dressing on the internal stresses in steel wires (in German), *Stahl u. Eisen* **78,** 25, 1822–1827, Dec. 1958.

Methods of examination to determine the strain in wires. Determination of the repartition of internal stresses of the external rim zones across the periphery of the steel wire which has been slightly curved when wound on the drawing block. Reducing the amount of internal stress by re-drawing or straightening as well as by stretching and tempering. Effect of the different types of deformation on the strength properties.

From authors' summary

3883. Budnick, G., The measurement of speeds on machine tools by means of electronic methods (in German), *VDI-Forschungsheft* **24,** 470, 52 pp., 1958.

The speed of machine tools covers a range of $1:10^7$, i.e. 1 μ/s up to 10 m/s in a frequency band from 0 to 500 cps. Speed-versus-time curves present a good knowledge about the machining process and the machine itself and are of importance not only to the accuracy of the workpiece and the quality of its surface but also to the serviceability of the tool. A thorough theoretical and experimental investigation into five speed-measuring methods led to the development of electronic measuring devices, covering the wide range of speed. For the lowest range an inductive gage with a carrier frequency system is used. For higher speeds a new capacitive measuring method was developed, followed by an inductive-dynamic system with extremely good frequency response. For long

strokes of measurement a new method was built up, depending on the eddy current effect. The highest accuracy is obtained by an impulse system using optical diffraction gratings and electronic short-time measuring techniques. For calibrating purposes a special device was constructed, producing "standard velocities" with high accuracy. From author's summary

Fracture (Including Fatigue)

(See also Revs. 3848, 3908, 3915, 4106)

3884. Powell, A., On the fatigue failure of structures due to vibrations excited by random pressure fields, *J. Acoust. Soc. Amer.* **30,** 12, 1130–1135, Dec. 1958.

This interesting paper presents a general analysis of the problem using the ideas of vibration theory and spectrum analysis. The basic assumption is made that the forced modes of vibration of a structure, subjected to pressure fluctuations random in time and space, can be approximated by the composition of uncoupled natural modes. The power spectrum, and hence the rms value, of any quantity depending linearly upon structural distortions is derived. Involved is a quantity termed "joint acceptance" concerning the spacewise structure of the pressure field and of the geometry of the modes of vibration. Under the assumption of "normal" randomness it is shown how this result may be used to estimate the fatigue life on the hypothesis of cumulative damage.

Immediate practical use of this general treatment embraces fatigue due to pressure fluctuations arising from the jet effluxes of airplanes. Aircraft skin vibrations excited from turbulent boundary layers and oscillations produced by wind loads in large bridges, chimneys, towers, antenna masts, may provide other fields of practical application. It should be noted that the basic assumption of an adequate representation of forced modes by a set of linear uncoupled natural modes may limit the general applicability of the theory. A. W. Coutris, USA

3885. Waisman, J. L., Soffa, L., Klooris, P. W., and Yen, C. S., Effect of internal flaws on the fatigue strength of aluminum alloy rolled plate and forgings, *Nondestructive Testing* **16,** 6, 477–489, Nov.–Dec. 1958.

3886. Fatigue under fretting conditions, *Engineer, Lond.* **206,** 5359, 566–567 (Metallurgical Topics), Oct. 1958.

3887. McEwan, A. D., Finney, J. M., and Mann, J. Y., An hydraulic random load fatigue test rig for simple specimens, *Aero. Res. Lab., Melbourne, Austral. Note* SM-245, 8 pp. + 8 figs., Apr. 1958.

A rig is described in which "chains" of specimens in axial loading may be subjected to a spectrum derived from gust loading data for civil transport aircraft. This is used in conjunction with a hydraulic rig suitable for applying a random load spectrum to complete aircraft wings. From authors' summary

3888. Loubser, R. S., Fatigue strength of thermit welded rails, Proc. British Commonwealth Welding Conference, 5 pp., 1957.

A laboratory investigation into the fatigue strength of thermit welded rails is described. An experimental stress analysis of a welded rail indicated that a maximum stress of 1.4 times the nominal bending stress is experienced, due to stress concentration at the edge of the weld. The influence of weld shape on the stress concentration factor is discussed. Fatigue tests were carried out on thermit welded and as-rolled rail specimens; it was found that the fatigue limit in pulsating bending is 44% lower for the welded rail. Superimposed constant longitudinal stress, as would be caused by temperature variations in the track, influences the fatigue strength of a welded rail to a marked extent. The reduction in fatigue strength of the welded rail is due to the adverse influences inherent to welded materials, combined with stress concentrations at changes of section. It is concluded that both aspects should be studied individually if a systematic improvement in the fatigue strength of welded components is to be achieved.

From author's summary

3889. Mak, S. L., Oleinik, N. V., and Pronin, V. M., Fatigue endurance of sample with side openings and drilled holes (in Russian), *Nauch. Zap. Odessk. Politekhn. In-ta* **9,** *55–60, 1956; Ref. Zh. Mekh.* no. 10, 1957, Rev. 12256.

The results are put forward of fatigue tests carried out on test samples of steel 6 and steel 40X in a normalized condition. The transverse openings and drill-holes were made with a drill of 3-mm diameter for 15-mm samples of steel 6 and with a drill of 8-mm diameter for 12-mm samples of steel 40X. Tests were carried out on an NU machine on the basis of 5×10^6 cycles. It was established that for both materials the fatigue limit and the "stress concentration factor K_σ" were practically the same for samples with openings and for drilled samples. The testing of samples with five rows of arranged drill-holes of identical depth showed no signs of the effect of interrelated unloading. Removal of the metal between the drill-holes altered the fatigue limits insignificantly, while the value of K_σ was somewhat reduced. The assumption is advanced that with a change in the length of the key groove the limit of fatigue should not vary to any noticeable extent. In all the cases fatigue fracture began from the edge of the openings or drill-holes. G. A. Tulyakov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3890. Thomas, T. Y., Rupture of round bars by tension, *J. Math. Mech.* **8,** 1, 1–26, Jan. 1959.

Paper deals with problem of identifying fracture surfaces in round bars under tension. Author defines such a surface as one wherein a small discontinuity increases indefinitely in a finite time. Using this criterion, author examines the specific cases of (1) plane transverse to axis, dividing elastic from plastic states, (2) surface of revolution about axis of bar, and (3) plane transverse to axis of necked bar at minimum cross section. Material is assumed to have sharp yield point, i.e., linear stress-strain curve in elastic region changing to horizontal line at yield stress. Equations are set down in tensor form for plastic flow, then defined in terms of generalized coordinates.

Author then presents definitive analysis of above three cases to show that both (1) and (3) are fracture surfaces, and that the proper surface of revolution for such condition is a circular cone around bar axis with generators at an angle of 35° 16' with plane axis.

Results are for ideal material and under condition of axial tension. Author also assumes that fracture follows propagation of a crack moving along surface of instability. Treatment is excellent analysis for these ideal conditions.

H. I. Fusfeld, USA

3891. Shevandin, E. M., Razov, I. A., and Serpeninov, B. N., Methodology of the investigation of failure in samples of various dimensions, with allowance for the yielding of the loaded system (in Russian), *Zavod. Lab.* **22,** 11, 1338–1342, 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9732.

A method is described of determining the inception of breakdown from the surface—the "method of marked cracks." The appearance of the cracks, their dimensions and growth in the process of stepwise loading are investigated by an instrumental microscope. Investigation of the transverse bending of geometrically similar notched samples of steel SKhL-1 has shown that increasing the dimensions of the sample does not affect the magnitude of the de-

formations at the beginning of breakdown, but considerably hastens the further development of the crack. It is concluded that the appearance of a scale effect in metals is associated with the value of the plastic energy accumulating in the system, and does not depend on a statistical factor. Yu. I. Likhachev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3892. Meissner, B. A., The investigation of stress concentrations in "Admiralty" samples (in Russian), *Zavod. Lab.* **22,** 7, 853-855; 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9736.

A comparison is made between the values of the coefficient of stress concentration obtained optically in the tension of an "Admiralty" sample, representing a plate with a narrow slit, and in the tension of a similar sample with a sharp notch at the end of the slit; the sharp notch causes a considerable increase in the value of the coefficient of stress concentration.

Author suggests using such tests for evaluating the tendency to brittle breakdown of welded parts owing to the presence of cracks and notches in the weld zone. M. I. Gusein-Zade

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Experimental Stress Analysis

(See also Rev. 4043)

3893. Clutterbuck, Margery, The dependence of stress distribution on elastic constants, *Brit. J. Appl. Phys.* **9,** 8, 323-329, Aug. 1958.

Author makes use of frozen-stress phenomenon in Araldite B to study effect of variation in Poisson's ratio on stress distribution in two and three dimensions. In two-dimensional models the stress distribution at room temperature ($\nu = 0.36$) and the stress distribution under an equivalent load (allowing for the variation of E) at the elevated temperature ($\nu = 0.48$) are both viewed in the normal polariscope. In three dimensions, the reflected-light technique is used as well as the method of slices.

Author concludes that differences in experimentally determined stress distributions due to Poisson's ratio effects are less than the errors introduced by other factors.

R. T. Severn, England

3894. Ohasi, Y., Three-dimensional photoelastic examination of a helical spring (in English), *Mem. Fac. Engng. Univ. Nagoya* **9,** 2, 279-283, Nov. 1957.

The stresses in a wire of a helical spring with a section have been obtained mathematically in a previous paper. The object of this paper is to examine the theoretical results by the frozen stress method. From author's summary

3895. Schwieger, H., and Reimann, V., Photoelastic investigations of lateral beam impact (in German), 9th Congrès Intern. Mécan. Appl., Univ. Bruxelles, 1957; **8,** 336-351.

An old problem is treated with new experimental remedy. The photoelastic effect is measured with the help of a cathode-ray oscillograph and the time is registered electrically. The material of the beam is glass. The results of the experiment are in good conformity with theory.

L. Foppl, Germany

3896. Weis, O., Photoelastic investigations of bending waves with exponential after effects (in German), *Acustica* **7,** 6, 402-408, 1957.

The appearance of exponential near-fields within the limits of validity of elementary bending-wave theory is discussed with reference to several examples. Certain relevant stress-optical observations are quoted.

From author's summary

3897. Senior, D. A., High-speed photoelasticity, *Engineering* **186,** 4824, 248-253, Aug. 1958.

3898. Cole, A. G., and Brown, A. F. C., Photoelastic determination of stress concentration factors caused by a single U-notch on one side of a plate in tension, *J. Roy. Aero. Soc.* **62,** 572, 597-598 (Tech. Notes), Aug. 1958.

3899. Yarema, S. Ya., The measurement of high-temperature stresses by means of resistance wire strain gauges (in Russian), *Nauch. Zap. In-ta Mashinoved. i Avtomatiki Akad. Nauk USSR* **5,** 25-40, 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9775.

The working of resistance-wire strain gages at high temperatures (200°) is investigated. The question of temperature stability is solved by aging the gages at 150-170° for 30 days, and repeated heating to 180-200° with slow cooling. The thermal treatment smoothes out the temperature coefficients of the gages within the limits of ± 2%, and produces a hysteresis effect not exceeding 3% in the indications of the gages when heated and cooled.

Measurement of the temperature stresses is performed by resistance gages cemented on the article to be investigated (positive gages), and on a plate of the same metal (compensating gages). The plate with the compensating gage is pressed against the positive gage with the interposition of a paper screen, to balance the temperatures of the plate and the experimental object. The bridge unbalance resulting from the presence of temperature stresses in the test piece corresponds to the value of the stress. The stresses are measured by the bridge method, using direct current. The temperature stresses established in the experiments amounted to –20 kg/cm² per 1° temperature difference between the surfaces of the test piece and the compensating plate. The influence of the thermal emf on the indications was compensated by measuring with different polarities of the voltage applied to the bridge.

Practical indications are given concerning the preparation of the gages and the conduct of the tests.

V. N. Maksimov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3900. Scott, I. G., Resistance changes in resistance strain gauges, *Aero. Res. Lab., Melbourne, Austral. Note* SM-244, 12 pp., Apr. 1958.

Gross resistance changes during the storage and attachment of resistance strain gages have been studied, and recommendations for the control of these changes are made.

From author's summary

3901. Scott, I. G., A gauge factor meter, *Aero. Res. Lab., Melbourne, Austral. Note* SM-243, 6 pp. + 2 figs., Apr. 1958.

An extremely simple instrument for the determination of gage factor of electrical resistance strain gages is described.

From author's summary

3902. Mason, W. P., Semiconductors in strain gauges, *Bell Lab. Record* **37,** 1, 7-9, Jan. 1959.

3903. Bride, W. L., Solution of strain gauge rosettes, *Engineer, Lond.* **207,** 5374, 144-145, Jan. 1959.

3904. Potocki, F. P., Vibrating-wire strain gauge for long-term internal measurements in concrete, *Engineer, Lond.* **206,** 5369, 964-967, Dec. 1958.

3905. Chapman, J. C., Stud-welded vibrating wire strain gauge, *Engineer, Lond.* **206,** 5361, 640-641, Oct. 1958.

3906. Congleton, J., and Parkins, R. N., A simple creep strain recorder for use with wire specimens, *J. Sci. Instrum.* **35,** 10, 379-380 (Lab. and Workshop Notes), Oct. 1958.

3907. Vasil'ev, D. M., Measurement of macrostresses by the x-ray diffraction method of angular photography (in Russian), *Zh. Tekh. Fiz.* **26,** 10, 2389-2395, 1956; *Ref. Zh. Mekh.* no, 1957, Rev. 12218.

The method is investigated for determining the macrostresses in samples which have undergone plastic deformation. The appearance of residual macrostresses during an uniform single-axis stressed condition is explained by the appearance in the sample of systems of oriented microstresses, distributed over the whole area of the sample. Methodical concepts are advanced for the introduction of corrections in regard to the influence of residual microstresses on the results of the determination of residual macrostresses. I. V. Vikker

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3908. Claydon, D. G. W., Instrumentation in ultrasonic flaw detection, *J. Inst. Metals* **86,** 241-251, 1957/58.

3909. Moore, M. G., and Evans, W. P., Mathematical correction for stress in removed layers in x-ray diffraction residual stress analysis, *SAE Trans.* **66,** 340-345, 1958.

Because x-rays are diffracted from surface layers only, a determination of stress distribution with depth requires removal of material to the depth desired. When stressed layers are removed, the successively measured stresses at depths below the surface must be corrected by an amount proportional to the relaxation created by the removed layers. This means that all determinations except the initial value at the surface must be corrected in order to obtain the true stress distribution that existed before the layers were removed.

Correction formulas are developed for the solid circular cylinder, the hollow cylinder or tube, and the flat plate. Symmetric and nonsymmetric peripheral stresses are taken for the solid cylinder. Examples are shown and limitations and applications of the formulas are discussed. F. Garofalo, USA

Properties of Engineering Materials

(See also Revs. 3849, 3881, 3882, 3885, 3923, 3936, 3938, 3940, 4092, 4106, 4113)

3910. Girifalco, L. A., and Grimes, H. H., The theory of diffusion in strained systems, *NACA TN* 4408, 39 pp. + 4 figs., Sept. 1958.

Detailed mathematical treatment is given of kinetic theory of diffusion by vacancy and by interstitial mechanisms in solid subject to homogeneous elastic strain or to uniform plastic strain rate. Brief account is given of diffusion under gradient of strain. Results are compared with published observations, and found to agree well. Diffusion coefficient varies exponentially with elastic strain and linearly with plastic strain rate.

Reviewer would have welcomed more detailed discussion of physical bases of theory, especially in demonstration that vacancy concentration should show no first-order variation with strain. F. R. N. Nabarro, So. Africa

3911. Brown, C. S., and Winter, K. G., The use of an Araldite coated iron casting as a liner for a supersonic wind tunnel, *Aero. Res. Counc. Lond., Curr. Pap.* 346, 4 pp. + 4 figs., 1957.

3912. Testerman, M. K., Evaluation of approaches to the study of the physical nature of metallic surfaces, WADC TR 56-233 (PB 121971; ASTIA AD 118 106), 49 pp. + 15 figs., Feb. 1957.

Various approaches to determine the roughness of a metallic surface are examined. A direct approach is considered the most feasible in studying the actual rather than the effective topography.

The proposed instrument makes use of the de Broglie matter waves and thus accomplishes a theoretical resolution of 0.75Å. Fifty-KV helium ions bombard the specimen at a small angle. The reflected ions are magnified through an ion microscope which detects a signal proportional to the quantity of the impinging ions. The surface of the metal is scanned and the detected signal, after being amplified, is recorded as a function of scanning. By comparing the results with a standard pattern of roughness, absolute measurements of surface fluctuations to the desired order of magnitude are made possible.

From author's summary

3913. Ensrud, A. F., Problems in the application of high-strength steel alloys in the design of supersonic aircraft, *SAE Trans.* **66,** 118-136, 1958.

3914. Doran, D. G., Fowles, G. R., and Peterson, G. A., Shock-wave compression of aluminum, *Phys. Rev. Letters* **1,** 11, 402-404, Dec. 1958.

3915. Bartenev, G. M., and Rozanova, V. I., Thermal endurance of glass in cooling (in Russian), *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk* no. 5, 62-69, May 1957.

Thermal resistance of various types of glass exposed to slow and sudden temperature changes is investigated on the basis of tests, and theoretical relationships are derived with references to previous studies and experiments, especially by K. Tabata and T. Moriya. Special cases are discussed, e. g. technical glasses of various thickness, very thin and massive, exposed to cooling on one and both sides, to uniform and concentrated temperature changes, and considering chemical composition of the glass and its characteristic aggregates. Mathematical relationships are derived for flat glass sheets, depending on temperature differences during the cooling period, thickness, coefficient of thermal transmission, strength of the glass and its modulus of elasticity. Results are demonstrated by photographs and diagrams. J. J. Polivka, USA

3916. Werren, F., Weathering of glass-fabric-base plastic laminates, WADC TR 55-319, Supplement I, 16 pp. + 15 tables + 36 figs., June 1958.

3917. Bartholomew, E. R., Elastomers for high temperature applications, *AGARD (Rep.)* 178, 8 pp. + 10 tables + 13 figs., Mar.-Apr. 1958.

The relatively new subject of elastomer technology is discussed. A review is given of the source and nature of high-temperature elastomer problems, and the limitations of the more conventional elastomer materials are discussed. Recent data on properties of special high-temperature polymers and their compounds are included. From author's summary

3918. Gent, A. N., and Lindley, P. B., The compression of bonded rubber blocks, Instn. Mech. Engrs., Prepr. 9 pp., 1958.

Experimental measurements are described of the load-deflection relations for rubber blocks having a wide range of thicknesses and for varied shapes of cross section. An approximate theoretical treatment is presented for classically small compressions of circular disks and infinitely long rectangular bars. The measured stiffnesses for small compressions are shown to be in good agree-

ment with the theoretical predictions for a vulcanizate containing no carbon black, and, when an empirically obtained modification is made for thixotropic effects, for vulcanizates containing various quantities of carbon black. The behavior under moderately large compressions is also examined.

From authors' summary

3919. Sekiguchi, H., The variation of characteristics in rubber vibration-isolator due to its curing conditions, *Bull. JSME* **1,** 3, 222-227, Aug. 1958.

3920. Huppert, P. A., New aspects in ceramic coatings, *ARS J.* **29,** 1, 19-22, Jan. 1959.

Requirements and problems created by ultra-high-speed and space flight conditions with emphasis on newly developed metal alloys and high energy fuels call for special high-temperature-resistant protective coatings. Recent achievements in modifying conventional ceramic coatings and application techniques are described, and lithium compounds as prime modifying constituents are discussed. From author's summary

3921. Pajevic, M., Light cellular concrete—contemporary building material (Croation-Serbian), *Naše Gradjevinarstvo* **13,** 1, 25-31, Jan. 1959.

Use of this material is steadily growing due to good thermal insulation and rapid construction. Important conditions for further development are discussed and recommended, such as serious preparatory work, organized research and close collaboration among industry, engineers and builders. Research work in Polish Testing Center and Yugoslav Institute of Testing Materials is thoroughly described, and mechanical equipment for mass production mentioned and illustrated.

J. J. Polivka, USA

Structures: Simple

(See also Revs. 3721, 3783, 3815, 3817, 3822, 3828, 3865, 3921, 3932, 4223)

3922. Ouvrier, E., Design of reinforced concrete columns with special regard to biaxial bending (in German), *Bautechnik* **34,** 7, 261-264, July 1957.

A solution in table form for the design of reinforced-concrete columns of rectangular cross sections in biaxial bending is given by developing a new method for solving the system of equations presented by Pucher [*Bauingenieur* 1940, p. 131].

The entire work with all tables has been published by Werner-Verlag GmbH, Düsseldorf. This article comprises the results of mathematical investigations as well as the table of the most frequently used reinforcement, i.e., the rectangular cross section with a bar of equal size in each corner.

K. Angervo, Finland

3923. Khalos, O., The limiting equilibrium of ferroconcrete plates (in Russian), *Izv. Akad. Nauk. SSSR, Otd. Tekh. Nauk* no. 8, 42-52, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 12131.

An investigation is made of the condition of the limiting equilibrium of a ferroconcrete plate, freely supported along its edges, with a single increasing load and with identical reinforcement in two perpendicular directions. The initial equation of the boundary condition is derived on the principle of possible transpositions. It is shown that the surface of possible transpositions, determining the maximum size of the boundary load, is ascertained by solving the differential equation. $z_{xx}z_{yy} - z_{xy}^2 = 0$ ($z = 0$ on the contour), where z_{xx}, z_{yy}, z_{xy} are curves of the surface of the transpositions. If the plate being investigated has a multifaced contour, then the solution of the equation introduced above would take into account the surface of the plane bits passing through the contour lines.

Kh. Kh. Laul'

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3924. Sahmel, P., Stressing of elastically restrained parallel and oblique frames using the Kani method (in German), *Stahlbau* **26,** 5, 140-144, May 1958.

Elastically restrained frames have not received due attention because of the complications involved in their stressing. The Kani method is more easily applicable to that type of restraint than the Hardy Cross method.

The author worked out the Kani method coefficients for a number of loading cases for the three restraint conditions: built-in, pin-jointed and elastically restrained.

Numerical examples of parallel and oblique frames have been worked out.

J. Solvey, Australia

3925. Popov, I. G., and Raevskii, A. N., Determination of the strength of some single-stage free frames (in Russian), 15th Sci. Conf. Leningrad, Engng.-Constr. Inst., Leningrad, 1957, 401-404; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 12064.

An examination is made of the static stability of multiple-span, single-stage free frames with unequal linear rigidity of the cross bars, and also of single-stage, free frames of the monotonous type with vertical bonds in the form of intersecting diagonal struts, under the action of a nodal load. A method of solution is proposed which permits bringing together the system of homogeneous canonical equations, derived by the transposition method, into a single equation for the critical state, avoiding the exposure of the determinant from the coefficients of the system, as is done in the general case. To do this a determination is made, from the canonical equations, of the angles of rotation of the frame's joints as a function of the linear transposition, and these are substituted in the equation expressing the equality to zero of the sum of reacting forces in the supplementary nodal fastenings, preventing the linear transposition of the joints. The equation arrived at in this fashion is then utilized for the determination of the critical parameter. The problem is solved by means of convergence methods with set values for the parameter.

A. F. Anishchenko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3926. Losaberidze, A. A., Strength of round arches under radial pressure, taking into account the elasticity of the foundation (in Russian), *Tr. Gruz. Politekhn. In-ta* **6,** 47, 12-15, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 12047.

An approximate method of solving the equations of stability is proposed

$$\lambda \cot \lambda\varphi_0 + (1 - \lambda^2)\rho = \cot \varphi_0$$

(the intensity of the critical load

$$p_{cr} = \frac{EI}{r^3}(1 - \lambda^2)$$

where r is the arc's radius, φ_0 is half the central angle of the arc

$$\rho = \frac{EI\gamma_1}{r}, \qquad \gamma_1 = \frac{12}{kb^3}$$

k is the coefficient of the foundation bed, b is the height of the rectangular section of the arc with width 1). Making

$$\lambda\varphi_0 = \pi + \epsilon, \qquad \cos \epsilon \approx 1 - \frac{\epsilon^2}{2}, \qquad \sin \epsilon \approx \epsilon$$

author replaces the transcendental equation by an algebraic one of the form $\epsilon^3 + b_1\epsilon^2 + b_2\epsilon + b_3 = 0$. A. A. Pikovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Structures: Composite

(See also Revs. 3824, 3825, 4016, 4206, 4207, 4208, 4209, 4210)

3927. Melosh, R. J., and Merritt, R. G., Evaluation of spar matrices for stiffness analyses, *J. Aero/Space Sci.* **25,** 9, 537-543, Sept. 1958.

Two new spar matrices developed for deflection analysis of structures by stiffness method are compared with the matrix based on elementary beam concepts. Convergence to the final stiffness coefficients is shown to be much more rapid using either of the new matrices.

Results from the analysis of a box beam by the stiffness method are shown to converge to analytical results obtained with elementary bending theory, including transverse shear deformation and shear lag corrections. T. H. Lin, USA

3928. Kochanski, S. L., and Argyris, J. H., Some effects of kinetic heating on the stiffness of thin wings, II, *Aircr. Engng.* **30,** 349, 82-85, Mar. 1958.

The present paper is a continuation of a previous paper [AMR **11** (1958), Rev. 3956]. Both papers concern approximate methods for predicting the influence of thermal stresses on the finite bending and twisting actions of their symmetrical double-wedge wings. A parabolic distribution of thermal stress is assumed across the chord. Using a power series representation of the chordwise deflection of the wing, estimates are made of the effect of tongue and thermal stresses on flexural stiffness and the effect of bending and thermal stresses on torsional stiffness. A number of graphs are presented to illustrate the trends obtained from the approximate theory.

R. L. Bisplinghoff, USA

3929. Obraztsov, I. F., The analysis of caisson shells for sweptback wings, by the theory of V. Z. Vlassov (in Russian), *Trudi Mosk. Aviats. In-ta* no. 59, 47 pp. + illus., 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9319.

A systematic analysis of the variational method of V. Z. Vlassov in application to the stress analysis of sweptback wings. The calculation of sweptback wings with rigidly encased root and in the presence of a midwing section is discussed in detail.

The calculated results are plotted in graphs. Experimental results are presented for the bending of sweptback spars; for the same spars, a stress analysis is made by the author's approximation formulas.

The results presented agree quite satisfactorily with the experimental results obtained.

L. I. Balabukh

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3930. Ivanova, T. V., and Kladnitsky, V. M., A graphical method for calculating the strength of some thick-walled vessels (in Russian), *Trudi Dalnevost. Politekhn. In-ta* no. 44, 21-31, 1955; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9291.

A graphical method is described for calculating thick-walled vessels, using the method of substituting the variable introduced by R. Grammel [cf. K. B. Biezeno, R. Grammel: "Engineering dynamics", Gostekhizdat, 1952, Vol. 2, p. 23]. The calculation is based on approximate formulas for the stresses in a thick-walled vessel, developed by these authors in a previous work [*Trudi Dalnevost. Politekhn. In-ta,* no. 37, 1949].

V. K. Prokopov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3931. Doluhanov, K., Design of square shafts in plain concrete (in Croation-Serbian), *Naše Gradjevinarstvo* **12,** 7, 164-168, July 1958.

Under certain exceptional circumstances concrete water tanks, shafts, bins have to be built without reinforcement, and the design of this type needs special considerations and details. Author presents an analysis based on properties of concrete used and recommends most suitable shape of walls and bottom slabs. Nomograms show pertaining dimensions for various sizes and surrounding conditions of these structural types.

J. J. Polivka, USA

3932. Szabo, J., Calculation of bridge grillages (in German), *Stahlbau* **27,** 6, 141-147, June 1958.

A method for the numerical analysis of grillages by means of matrices is given. By using the well-known Clapeyron equations for continuous beams, a simple matrix expression for any beam in the bridge grillage is established. The matrices entering this expression are, as they should be, of the "difference-equation type". From this relation for the beams a similar matrix equation for the grillage is obtained. Statical loads and thermal loads are permitted.

A list of inverse matrices and other entities of value for computations is given and a numerical example illustrates the procedure. (Equation [12] should be $\zeta A \cdot S + S \cdot B = D$; by a misprint the factor A is missing.)

B. Langefors, Sweden

3933. Elias, E., On the forces of the suspension bar of arch bridges (in German), *Acta Techn., Acad. Sci. Hungaricae, Budapest* **22,** 3/4, 349-360, 1958.

The discussed structure consists of arch, stiffening beam and hangers. For the stress analysis of this structure, as is well known, two methods occur in the literature. The first replaces the hangers by a continuous hanging, e. g., G. Haviar [AMR **3** (1950), Rev. 1918]. The second takes into account the finite number of the hangers, e. g., the book of A. J. Astwazaturov (in Russian). Author applies the second method, and, at the same time employs the matrix calculation. The result shows that the first method meets, in any practical case, the requirements of precision.

J. Barta, Hungary

3934. Kmosko, K., Railway culverts (in Hungarian), *Mélyépitéstudományi Szemle* **7,** 9/10, 307-316, Sept./Oct. 1957.

Author states that in the design of master plans for railway culverts, the weight of a high dam itself gives the most unfavorable loading condition, because the ratio of the horizontal and vertical components of the earth pressure varies between wide limits. The most suitable form of the cross section consists of a flexible construction, or by taking several elements which form a pliable construction. The axis of strength should be nearly a circle. The design conditions are fulfilled only if the fill on both sides of the culvert has been compacted thoroughly.

When constructing a new railroad, it is recommended, however, to build a rigid concrete culvert with the cast-in-place method; but where a new culvert is to be installed in an existing dam, pipes with thin walls and circular cross section are preferable.

A. Kezdi, Hungary

3935. Nowinski, J., The influence of rigid fixing on the stresses at the base of a dam with rectangular cross-section (in English), *Arch. Mech. Stos.* **9,** 4, 455-466, 1957.

The stress functions for a dam of rectangular cross section, given by M. Levy, assume free warping at the bottom of the dam. Author derives the stress functions for the opposite limit case of perfectly rigid fixing of the dam at the base. Author calculates that the maximum normal stress at the base of the dam in the case of rigid fixing is 46.5 % higher than according to classical approach, and the maximum shear stress almost 20 % higher.

F. C. de Nie, Holland

Machine Elements and Machine Design

(See Revs. 3761, 3861, 3967, 4091)

Fastening and Joining Methods

3936. Van Houten, G. R., A survey of the bonding of cermets to metals, *Welding J.* **37,** 12, 558-569, Dec. 1958.

Brazing cermets to metals is complicated by the great differences in thermal coefficients of expansion and by the difficulty in finding braze metals which will wet cermet surfaces. The need for brazes which are strong at high temperatures (and therefore melt at even higher temperatures) further increases the problem of differential expansion.

This literature survey reviews metallizing history, joint design, joint materials, methods of wetting, methods of increasing braze strength, methods of correcting for differential expansion, and other topics pertinent to the production of a strong high-temperature braze for cermets.

From author's summary

3937. Eickner, H. W., Effect of surface treatment on the adhesive bonding properties of magnesium, For. Prod. Lab. Rep., U. S. Dept. Agric. no. 1865, 19 pp. + 12 tables + 4 figs., June 1958.

3938. Huseby, R. A., Stress relieving of stainless steels and the associated metallurgy, *Welding J.* **37,** 7, 304-s - 315-s, July 1958.

3939. Luthy, A., Special welding problems in nuclear engineering, *Brown Boveri Rev.* **45,** 6, 272-279, June 1958.

The execution of welds in pressure vessels and pipes of mild or low-alloy steel presents no fundamental problems. With high-alloy steels, or different metals and alloys, whose weldability may be questionable, it is quite another matter. The present article first deals briefly with normal welds in pressure vessels and pipes, then examines some special cases in nuclear engineering where the execution of pressure-tight welds presented certain problems. Sketches and photographs of welds used for a power reactor illustrate various points covered.

From author's summary

Rheology

(See also Revs. 3794, 3969)

3940. Hookway, D. C., The cold-drawing of nylon 6.6, *J. Textile Inst., Proc.* **49,** 7, 292-316, July 1958.

Experimental work studies effect of ambient condition and undrawn yarn structure on load-elongation curve of a 71-denier nylon fiber. Necking-down process during cold drawing is investigated in detail, also the conditions for the propagation of the interface. Suggestion is made that drawing at a neck is equivalent to melting at reduced pressure at the center of the neck. A quantitative description of theory is attempted and discussed in the light of mechanisms proposed by others.

As in metals, occurrence of strain-induced porosity in the necked region is explained by existence of hydrostatic tension at cusp of the neck.

F. Forscher, USA

3941. Gupta, A. S., Shear flow of a viscoelastic fluid past a flat plate with suction, *J. Aero/Space Sci.* **25,** 9, 591-592 (Readers' Forum), Sept. 1958.

Sakurai's study [*J. Aero. Sci.* **24,** p. 79, 1957; AMR **10** (1957), Rev. 2614] on the laminar boundary layer along an infinite plate in uniform shear flow and with uniform suction has been extended to include the case of a viscoelastic fluid. Since conditions are independent of the axial coordinate, the transverse velocity is constant and equal to the suction velocity, and there is only an axial, constant, pressure gradient. A relation between pressure gradient, the vorticity of the free stream and the suction velocity is obtained identical to Sakurai's. The effect of elasticity results in a decrease of the boundary-layer thickness.

J. O. Hinze, Holland

3942. Holzmuller, W., Viscous deformation and flow as a dislocation phenomena (in German), *Kolloid Z.* **155,** 2, 110-116, Dec. 1957.

Paper discusses place-changes of particles under the action of force-based thermal effects and attempts to relate both viscous and plastic deformations to those effects. Since the operation of thermal place-changes in the assumed quasi-ordered structure requires the existence of "holes", the proposed theory seems to imply that both viscous and slip-deformation are of similar origin, and that the latter therefore does not proceed by the motion of disloactions.

A. M. Freudenthal, USA

Hydraulics

(See also Revs. 4013, 4016, 4036, 4047, 4054, 4058, 4129, 4213, 4226, 4235, 4236)

Book—3943. Francis, J. R. D., A textbook of fluid mechanics, New York, St. Martin's Press, Inc., 1958, viii + 332 pp. $6.50.

Author of this new textbook had to master a difficult problem to confine the wide realm of modern fluid mechanics into a handsome book of some 300 pages. His work is a significant step forward in the specific British traditions: so many bright ideas were there originated, and still some old fallacies prevail through generations. The value of this book is its splendid language, perfect print and clear sketches, some in two colors, so unusual in technical publications. Units are correct (only Lb is used instead of lb). The chapter on gas flow and compressible fluids is contributed by G. Jackson. Author, obviously, was very limited in space. Therefore open channels are only of rectangular section, there are no partly-filled pipes. Author ignored the Coriolis factor, although he gave an example of computation of the average kinetic energy (p. 36), which was obtained as high as 1.15. The flow net is favored, but its construction is left to "soft pencils and plenty of india rubber," earlier called "divider and eraser method"; there are more modern methods available. Darcy formula (author writes d'Arcy), universally known, is given (p. 203) with a traditional error, continuing the confusion. Reviewer suggests this regrettable error be eliminated in future editions. Sketches of the Stanton diagram (12.6, 12.11, 13.10) are to be improved too. Limit of the Reynolds number for laminar flow in open channels is about 500, not 1500. Name of Kaplan is Viktor, not N.

S. Kolupaila, USA

3944. Venkatasubramanian, V. S., On the structural part of the compressibility of liquids, *J. Indian Inst. Sci.* **40,** 3, 132–139, July 1958.

The "structural" part of the bulk modulus, represented by the contribution of the entropy term in the free energy, is examined and related to the temperature coefficient of the bulk modulus. This quantity is computed for the harmonic oscillator and free volume models, as also on the basis of a simple kinetic theory treatment. The values agree with experiment as regards the order of magnitude.

From author's summary

3945. Jacobs, R. B., Single-phase transfer of liquefied gases, *Nat. Bur. Stands. Cir.* 596, 42 pp., Dec. 1958.

Current practice calls for transporting liquefied gases over considerable distances in insulated tanks and vessels. Greatly increased use of liquefied gases suggests transportation through suitable piping systems. The document covers a theoretical study of the single-phase transfer of liquid gases over long distances. Experimental verification has not been accomplished as yet, but planned experiments are in progress. A system of equations is presented and the necessary empirical information furnished for the solution of particular long-distance transfer systems. Data required for numerical computations involving helium, hydrogen, nitrogen and oxygen are presented in graphic form. Solutions for several problems involving hydrogen and oxygen are presented.

Based on the assumption that the theoretical analysis is valid, the author reaches the three following conclusions: Using conventional pumping equipment and known insulating techniques it is feasible to pump liquefied gases over long distances; design calculations for the systems under consideration are straightforward and are not complicated, and while some transfer systems can be designed so that transfer losses are within reasonable limits, other systems are impractical. The article is recommended for those interested in the transfer of liquefied gases over long distances.

G. A. Hawkins, USA

Book—3946. Martinec, J., The effect of river channel roughness on the velocity of flow [Vliv drsnosti koryta na pohyb vody ve vodních tocích], Praha, Výzkumný Ustav Vodohospodárský Práce a Studie (Vol. 96), 1958, 72 pp. (Paperbound)

Results of special measurements in selected reaches on several rivers in Czechoslovakia were used for examination of existing formulas for average velocities, which include the bottom roughness. A median size of the sediment particles was measured as representative of the absolute roughness of bottom. Set of 79 measurements was used for verification of formulas by Chezy, Strickler, Manning and Agroskin, and also for establishment of author's formula, similar to that of Agroskin. Formula for the Chezy factor, in metric units, is $C = 17.7 \log R/d + 13.6$, or, in English units, $C = 32 \log R/d + 24.6$, where R is the hydraulic radius, d the average height of bed roughness, both in meters or feet. Limits of R were 0.15 to 2.25 meters, slope between 0.00004 and 0.0039, and d between 0.004 and 0.25 meters.

S. Kolupaila, USA

3947. Shima, S., and Tominaga, M., On the discharge ratio of supercritical flow in branching channels (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 58, 55–62, Sept. 1958.

It has been recognized that the characteristic of supercritical flow in an open channel is similar to that of compressible fluid of two dimensions. Therefore, the discharge ratio of supercritical flow in branching channels was theoretically obtained by studying the same problem as Prandtl-Meyer flow; at the same time it was investigated experimentally.

The experimental results were somewhat different from the theoretical ones, but it has been concluded that this theory is of practical use by adopting a supplementary coefficient.

From authors' summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

3948. Szesztay, K., The determination of monthly mean discharges from the mean stage (in Hungarian), *Hidrológiai Közlöny* **38,** 2, 123–134, Apr. 1958.

Effort is made to simplify determination of the average monthly discharge directly by the average monthly stage. Correction is necessary due to the shape of a discharge curve. This correction is usually related to the horizontal deviation of the curve from a chord, which connects the limits of stage fluctuation during the month. Author discovers a close relationship between the monthly stage variation and the mean deviation of daily stages. A complex diagram is to be developed for every gaging station, which would permit more accurate correction for the monthly discharge.

Reviewer cannot see any improvement in comparison with the traditional daily computation of the river runoff, particularly when corrections are due to the shifting bed, ice phenomena and ice cover, backwater, etc. Direct transformation of the monthly stages into monthly discharges may be admitted only in rivers with little fluctuations, e.g., flowing out from large lakes or storage basins.

S. Kolupaila, USA

3949. Ivicsics, L., Some hydraulic problems of planning settling tanks, Part I (in Hungarian), *Víz. Közl.* no. 1/2, 113–140, 1957.

The most important problem in the design of settling tanks is to establish a constant and uniformly distributed velocity of flow and to eliminate dead spots inside the tank, particularly when direction of approach is oblique. Transition chambers and other arrangements of entrance and exit were tested and compared. Laboratory experiments gave some outlines necessary to assure favorable conditions. Different arrangements are presented.

S. Kolupaila, USA

3950. Ivicsics, L., Hydraulic designing of settling basins, determination of settling velocity, Part II (in Hungarian), *Víz. Közl.* no. 3, 234–281, 1958.

In this second study the dimensioning of length of settling tanks is investigated, which depends on the settling velocity of particles. Formulas are discussed, which were proposed by many authors, American and Russian. Tests were performed with natural and artificial particles of ellipsoidal form. Their conduct in water was fixed by moving picture camera. Settling of grains was measured by photocells. A form factor was introduced to reduce the actual size of particles to the ellipsoids. When flow is turbulent, the settling velocity is a function of the velocity of flow.

S. Kolupaila, USA

3951. Vágás, I., Flow in two-stage settling basins (in Hungarian), *Hidrológiai Közlöny* **37,** 4, 356–365, 1957.

Flow patterns in different settling tanks are investigated. Indicator solution is used for determination of hydraulic efficiency. Characteristics of basins were different and not directly comparable. The most suitable form is suggested. Further, the theory of flow through a basin is studied, similar phenomena are encountered as a loop instead of a curve during flood in natural channels. A differential equation of storage fits for both basin surges and flood waves.

S. Kolupaila, USA

3952. Grubskii, B. A., The union of a cylindrical stream with an open flow (in Russian), *Trudi Kievsk. Gidromelior. In-ta* no. 5, 29–35, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12656.

Laboratory investigations are described on the union of a cylindrical stream with an open flow of rectangular section: (1) at different outlet velocities in the stream (pipe), (2) at different positions of the stream above the bottom, (3) at different ratios of the width of the open flow to the diameter of the stream, (4) at different depths of the stream. Three cases of outflow are examined [free, semi-submerged (flooded) and submerged], for which a qualitative characteristic of the flow is made. In the case of the flooded outflow, relations are constructed for the fall of levels in the flow between the section at the inlet of the stream and the section at the place with normal depths and for the length of channel in which the stream energy is extinguished.

T. N. Astaficheva

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3953. Chernov, Yu. V., and Topchevskii, B. A., Empirical formulas for the mean velocity of motion of a liquid in open flows (in Russian), *Trudi In-ta Nefti, Akad. Nauk KazSSR* **1**, 76–87, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12687.

Authors have collected and analyzed the references in the literature to the empirical formulas for the mean velocity of motion of a liquid in open flows, which do not contain a roughness parameter, namely: the formulas of Shezi-Brams, Gerlacker, Sribnoi, Gessl, Germanek, Humphreys and Abbot, Cann, Christian, Matakevich and Lindboe.

On the basis of an analysis of Kuznetsov's formula, and those of Nikuradze and Zheleznyakov, authors deduce their own formula for C of the exponential type, also not containing a roughness parameter, for which they substitute the declination, mean depth and coordinate of mean velocity. The comparisons carried out of the calculations for C according to the authors' formula and those in the above-mentioned empirical formulas are recorded in curves (which regrettably do not include a key to the curve and formula numbers). Authors arrive at the conclusion that Shezi's expression for C for an open flow can be converted to an exponential relationship, as proposed by the authors, but that, nevertheless, not one of the empirical formulas can be completely fitted into this relationship. The limits of application of the empirical formulas are established.

A. M. Latyshenkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3954. Vinogradov, M. I., Hydraulically optimum sections of trapezoidal canals (in Russian), *Trudi Mosk. In-ta Inzh. Zh.-d. Transp.* no. 88/89, 75–83, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12690.

In this study author shows that in designing canals of trapezoidal outline it is possible to allow significant departures from the hydraulically most effective section, since the increase of relative width by comparison with the hydraulically most effective section results in only an insignificant increase of the area of the live section. To provide proof of this the author, using Manning's formula, investigated the relationship

$$\frac{w}{w_0} = \sqrt[4]{\frac{(\beta + m')^2}{4(m' - m)(\beta + m)}}$$

where w is the area of the live section of the canal being designed and w_0 is the area of the hydraulically most effective section. Analogous deductions are to be found in abstractor's book [A. A. Uginchus, Canals and installations on them, Gosstroiizdat, 1953, 21-27, 60-89].

A. A. Uginchus

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3955. Levanovskii, L. B., Stable shapes for transverse sections of canal beds (in Russian), *Trudi Aralo-Kaspiisk. Kompliksnoi Ekspeditsii Akad. Nauk SSSR* no. 7, 61–69, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12702.

Preliminary conclusions are made known of the field experiments on the stable parts of the bed of a number of canals in the downstream portions of the Amu-Dar'ya in the range of flow 0.1 - 200 m^3/sec, widths 1.8 - 160 m and velocities 0.2 - 1.4 m/sec. The data obtained were compared with the empirical hydromorphometric connected data by S. T. Altunin, V. G. Glushkov, A. N. Gostunskii, Lacey, S. I. Rybkin and G. S. Chekulaev.

V. N. Goncharov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3956. Rebrov, G. F., Determination of the actual capacity of water-transmitting lines (in Russian), *Trudi Rostovsk-n/D. Inzh.-Stroit. In-ta* no. 5, 279–282, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12674.

The actual capacity of water-transmitting lines is to be determined, as proposed, on the basis of utilizing the discharge characteristics or the moduli of discharge of pipe conduits K, determinable in situ by the experimental method for separate portions of the pipe system. The extent of decrease in the capacity of the water pipe system is established by comparing the modulus of its discharge with the corresponding tabular value, while the loss of pressure in it is determined by a computation method, knowing the length of this section, the discharge from it and the value of K.

A description is given of the determination of the modulus of discharge K, based on the exclusion of the test section from the operation, the dismantling of the piping equipment in the wells at the beginning and the end of this section and the installation of special devices and apparatus for the determination of the discharge and pressure.

V. I. Gotovtsev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3957. Zababurin, I. A., Hydraulic resistances of deep-seated traps of circular section (in Russian), *Gidrotekhn. Stroit.* no. 2, 41–43, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12669.

The experimentally obtained coefficients of resistance for the inlet of a cylindrical tube with rounded edges are given for different openings of a flat grid for the case when the tube is on the bottom. The mean value of the coefficients varies from 0.75 to 122. On the basis of these data empirical formulas are obtained for the determination of the coefficient of resistance

$$\zeta_s = 0.75 + 3.70\left(\frac{1}{s} - 1\right)^2, \quad s = \frac{b}{D + 2r}$$

and when the height of the threshold is greater than the diameter of the tube

$$\zeta_s = 0.35 + 3.70\left(\frac{1}{s} - 1\right)^2$$

Here b is the distance from the edge of the grid to the rim of the rounded part, D is the diameter of the tube, r is the radius of the rounded edge of the mouth of the tube. The values obtained by the author for the coefficients at full opening (0.75 and 0.35) are several times as large as those found in the literature. The decrease in the coefficient of resistance with the increase in the height of the threshold is at variance with the change of the coefficient of discharge between full and partial compression according to N. N. Pavlovskii.

B. K. Konopkin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3958. Bozsony, D., Venturi flume experiments (in Hungarian), *Hidrológiai Közlöny* **37**, 2, 149–157, 1957.

Small models of different shape of Venturi flume were investigated in a laboratory. The influence of submergence was determined for various throats built following Lamoen curves. A chute in the bottom of the throat was tested to ascertain a free flow. The Parshall type was found the most suitable.

S. Kolupaila, USA

3959. Major, P., Scale-model investigation of the entrance-flume at the Kvassay hydro-electric station (in Hungarian), *Hidrológiai Közlöny* **37**, 2, 105–108, 1957.

Investigations were carried out to determine the preferable design and setting of the submerging wall to be installed in the entrance-flumes of reversible pump-turbine units. The tailwater level being fixed by specifications, the units operate as turbines in periods of high headwater levels but reverse to pumping operation at times of low river stages. Under the latter conditions the entrance flume of the power station acts as the suction chamber for the pump. The installation of the submerging wall is deemed necessary in order to exclude air from the spiral case and to ensure reliable syphon action.

On the basis of these experiments the relation between delivery head, pump discharge and degree of opening of the submerging wall (pump-gate) has been established, enabling the designer to select the proper gate opening ensuring the discharge required.

Experimental results have revealed the vertical setting of the submerging wall to be of no significance under certain conditions.

From author's summary

3960. Childs, E. C., A treatment of the capillary fringe in the theory of drainage, *J. Soil Sci.* **10**, 1, 83–100, Mar. 1959.

The hodograph treatment of the problem of drain design, as developed by van Deemter, is suitably modified to take into account the presence of a capillary fringe above the water table. Examples are presented to show that the presence of the fringe requires an increase of optimum drain size, and that thick fringes are accommodated mostly above a water table which is not proportionately much depressed below that which is appropriate to an absence of fringe, while thin fringes are accommodated in approximately equal proportions above and below the level of the fringeless water table.

From author's summary

3961. Grishook, I. K., Concerning the mechanism of water deaeration in jets (in Russian), *Teploenergetika* no. 4, 40–44, 1957.

Certain experimentally established particulars with regard to deaeration mechanism of water splashed into jets in the upper part of deaerator. Ejecting capacity of falling water-jets is shown to diminish the effect of deaeration.

From author's summary

3962. Mohr, W., Vibrational cavitation with short sound pulses (in German), *Acustica* **7**, 5, 267–277, 1957.

The cavitation process from the growth of the nuclei to the proper cavitation oscillation may be analyzed on a time base by utilizing sound pulses (20 to 5000 μs). The compression waves originating from the oscillating cavities during a pulse are recorded electrically and used as a statistical measure for the cavitation. Dark field observation together with photographic recording completes the investigation.

Cavitation is examined as a function of (a) pulse length and intensity of sound, (b) pulse interval, and (c) gas content of the fluid (water). During the growth of the nuclei the cavitation effect increases proportionally to pulse length and intensity. The characteristic of this effect becomes steeper at the beginning of the cavitation oscillations. As a result of the radiation pressure, shorter pulse intervals cause a lower density of nuclei in the sound field, and therefore cavitation becomes weaker. If the water contains gas and the pulse intervals are short enough, cavitation will recommence (secondary cavitation), depending on the relative gas content of the fluid.

From author's summary

3963. Golinskii, B. L., Problem of the passage of discharges close to rectilinearity when divided in an ideal flow, and of the corresponding border problems of the Keldysh-Sedov type (in Russian), *Trudl Khar'kovsk. Aviats. In-ta* no. 16, 109–122, 1955; *Ref. Zh. Mekh.* no. 5, 1957, Rev. 5507.

An investigation is made of the passage of discharges E^1, differing little from a system of sections of a straight-lined E. A system of sections C is laid out on the same straight line, this system containing vortices with a consistency of γ/u. The integral equation of the problem is solved with the aid of methods developed by N. I. Akhiezer [*Izv. Akad. Nauk. SSSR* **9**, 275–290, 1945]. In this way, a new deduction is obtained for Wagner's equation for an irregular motion of the wing [*ZAMM* **5**, p. 17, 1924]; found anew were: the flow around a cut wing first obtained by S. A. Chaplygin and of the grid, built up of sections of one straight section [L. I. Sedov, "Plane problems in hydrodynamics and aerodynamics," Gosteizdat. Moscow-Leningrad, 1950]. In addition to this, a flow around system of discharges was discovered which approximated the axis x in the presence of two parallel solid walls, placed at equal distances on both sides from axis x.

M. I. Gurevich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3964. Kononkin, B. K., Investigation of a spillway with a wide apron (in Russian), *Nauch. Zap. Poltavsk. In-ta Inzh. S.-kh. Str-va* no. 3, 173–185, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12692.

Approximate formulas are deduced for the determination of the discharge of water through a flooded and unflooded spillway with a wide apron. In solving the problem of the flow of liquid across the spillway with a wide apron the law of the conservation of mechanical energy (Bernoulli's equation) is applied, taking into account the curvature of the flow on the threshold. For the unflooded spillway the first section is placed in the "upper water" of the spillway, where a slowly changing movement is observed, while the second is observed on the threshold of the spillway at the place of convex or concave free surface, but in such a way that the tangent to the free surface at this point shall be horizontal. The discharge through the unflooded spillway is determined by the formula

$$Q = \varphi bb \sqrt{2g\left(H_0 - b = \sigma_r \frac{v^2}{2g}\right)}$$

where

$$\varphi = \sqrt{\frac{1}{\alpha + \Sigma\zeta}}$$

φ is the usual velocity coefficient of the unflooded spillway, σ_r the coefficient which takes into account the curvature of the flow on the apron, for the determination of which a curve is given. For the flooded spillway the second section is selected in the "lower water" of the spillway where the flow turns into a streamline one. At the same time the discharge through the flooded spillway is determined by the formula

$$Q = \varphi_H Hbb_\sigma \sqrt{2g(H_0 - b_H)}$$

where b_σ is the actual depth of the "lower water," b_H is the depth in the "lower water" relative to the apron of the spillway.

T. N. Astaficheva

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3965. Vinogradov, M. I., and Kirsanov, M. V., Hydraulic resistance of glass water-transmitting tubes (in Russian), *Trudi Mosk. In-ta Inzh.-d. Transp.* no. 88/89, 3–13, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12667.

In order to determine the hydraulic resistance of glass tubes, experiments were carried out in the MIIT hydraulics laboratory on a glass tube with an external diameter of 57 mm in the range of Reynolds numbers from 10^4 to 36×10^4. The tubes with lengths from 3 m were joined together by means of rubber sleeves bound with wire for additional strength. Pressure losses were determined by piezometers with pressure feed, the discharge by the volumetric method, while the inside diameter of the tube was obtained by weighing an empty tube and a tube filled with water. The experiments showed that the glass tubes tested have a somewhat larger hydraulic resistance than smooth tubes (the coefficient of friction λ is 70, higher than that obtained by Prandtl and Altschuhl formulas for hydraulically smooth tubes) which, in the authors' view, is explained by the influence of the joints. However, consideration of the fact that an increase in resistance of glass tubes in comparison with hydraulically smooth ones is observed mainly at high Reynolds numbers makes it possible to deduce that the glass tubes tested cannot be accepted as hydraulically smooth and that their evaluation must proceed according to the generalized formulas taking into account the roughness factor.

A. D. Al'tshul'

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3966. Karev, V. N., Hydraulic resistance of welded bends (in Russian), *Gaz. Prom-st'* no. 2, 33–35, 1957; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11574.

Results are published of tests carried out on four welded three-sectional bends of tubes with diameters of d = 306, 254, 158 and 78 mm, altering the flow direction by 90°. The equivalent radius of curve R of the bends was different: R/d = 0.7 to 0.8 for d = 306 and 254 mm; R/d = 1.85 to 1.95 for d = 158 mm, and R/d = 1.95 to 2.45 for d = 78 mm. The tests were carried out at high Reynolds numbers. A curve is given showing the dependence of the coefficient of resistance of these bends on the absolute size of the diameter d. With increase of the tube's diameter the resistance coefficient ζ of the welded bend decreases from a value of 0.7 for a tube of 78-mm diameter up to the value of 0.25 to 0.22 for tubes of 254 to 302-mm diameter. The influence of ζ on the welded bend indicates internal welded seams.

B. I. Yan'shin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

3967. Yaroslavtsev, I. A., Investigation of the work done by transporting (conveyor) hydromechanical installations using solid deformed models (in Russian), *Trudi Mosk. In-ta Inzh. Zh.-d. Transp.* no. 88/89, 115–128, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12697.

Article gives a detailed analysis of the criteria of similarity applied in engineering hydraulics and also looks into the question of the possibility and necessity for the simulation of natural roughness when reproducing stretches of rivers in model form. Author establishes that, for natural rivers, the absence or conservation of the similarity of roughness in nature and in the model has no practical significance. In proof of this, results are given of experiments carried out by the author with variation of relative roughness in the model of 6.5 times (from 0.075 to 0.5 cm). According to A. P. Zegzhd's curve for the coefficient of resistance, λ should have varied from 0.007 to 0.015, while actually on the model the variation was only from 0.058 to 0.061. Author deduces that the resistance of natural flows is determined by the character of the relief outline of the flow and not by the micro-roughness of the walls and bottom, and proposes that for altered simulation to apply the method of calculation be used based on M. A. Velikanov's concept regarding the "active" Froude number v^2/gil. A formula is given for the limiting possible alteration of scales for the simulation of velocities, discharge, etc. In order to enable an optimum to be formed regarding the permissible alteration in shape of the simulated flow on the basis of the cycle of experiments carried out by the author, it is recommended that the criterion $h/R \leqslant 1.2$ be used. At the end of the article a comparative example of the calculations is put forward for the altered river flow model, using the method proposed by the author and by the usual method, based on Froude's criterion. In conclusion, author reviews the limitations of application of his recommended method of altered simulation and of the usually adopted method of modelling according to Froude. The paper is somewhat difficult to read and understand because of the absence of classification and explanation of a number of symbols and signs employed by the author.

A. M. Latyshenkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Incompressible Flow

(See also Revs. 3708, 3953, 3961, 4013, 4021, 4049, 4052, 4063, 4111, 4162, 4255)

3968. Yih, C.-S., Two solutions for inviscid rotational flow with corner eddies, *J. Fluid Mech.* **5,** 1, 36-40, Jan. 1959.

In steady two-dimensional flow of inviscid liquid the vorticity is a function of the stream function. By assuming the velocity distribution far upstream in a channel of breadth 2 to be proportional to $\cos 1/2\,\pi y$, where y is distance from the center line of the channel, the familiar parabolic distribution of viscous flow is approximated. If the channel is blocked downstream by a barrier, straight across it, at whose center a sink is placed, the streamlines of the flow turn out to be lines passing from far upstream through the sink together with closed streamlines or eddies in the corners formed by the barrier and the channel walls. The inviscid flow thus yields a qualitative model of viscous flow in a channel with an abrupt contraction downstream. A corresponding result is found for inviscid flow in a tube, but here it is possible to take a true parabolic distribution upstream.

L. M. Milne-Thomson, USA

Book—3969. Swainger, K., Analysis of deformation. Vol. III, Fluidity, New York, The Macmillan Company, 1956, xxvii + 266 pp. $13.

Present volume follows in presentation and spirit the first two volumes. After two chapters of Introduction and Mathematical foundation, classical analysis of hydrodynamics is represented briefly in Chapter III, to allow easier reference. Chapters IV and V present author's theory of viscous flow; Chap. VI gives a theory of plasticity defined as "stress-fluidity". There are two appendixes on vector analysis and rigid body motion. For general appreciation of work, compare reviews of first volumes [AMR **7,** (1954), Rev. 3825, AMR **8,** (1955) Rev. 2995] In present volume author attacks both Euler's nonlinear "convective" acceleration term and Bernoulli's theorem. He is the first to include body and inertia forces in the seemingly so simple problem of viscous traction and claims that this shows that the Navier-Stokes equations fail in this case. He predicts that acceptance of his theory will lead "to more than a tremor of the old ideas". Reviewer hopes that experts will give these theories due attention and evaluate author's claims.

M. Reiner, Israel

3970. Jenson, V. G., Viscous flow round a sphere at low Reynolds numbers (< 40), *Proc. Roy. Soc. Lond.* **(A) 249,** 1258, 346-366, Jan. 1959.

Velocity, pressure and vorticity distributions are obtained by a relaxation process for flow past a sphere within a pipe. A novel continuously-variable lattice spacing is used. Calculated drag coefficients, corrected for effect of pipe wall, compare favorably with experimental results.

D. W. Appel, USA

3971. Khamrui, S. R., On the flow of a viscous liquid through a tube of elliptic section under the influence of a periodic pressure gradient, *Bull. Calcutta Math. Soc.* **49,** 2, 57-60, June 1957.

The velocity of a viscous fluid flowing along a tube of elliptic section under the influence of a periodic axial pressure gradient is determined in terms of Mathieu functions, assuming that the velocity is directed axially and is independent of distance along the tube. For small frequencies the velocity and pressure gradient are in phase and the motion at each instant is the same as if the pressure gradient is constant. For large frequencies there is considerable modification of the flow near the tube walls.

Reviewer believes the method could be generalized to account for flow in an annular tube with section bounded by confocal ellipses.

E. E. Jones, England

3972. Khamrui, S. R., On the slow steady motion of an infinite viscous liquid due to the rotation of a cylinder, *Bull. Calcutta Math. Soc.* **49,** 2, 61-66, June 1957.

An integral equation method is used to determine the couple necessary to maintain a cylinder of general cross section in steady rotation when set in a viscous fluid. The Stokes approximation for slow steady fluid motion is assumed. Applications of the theory involve cylinders of circular and elliptic sections.

E. E. Jones, England

3973. Thom, A., and Apelt, C. J., The pressure in a two-dimensional static hole at low Reynolds numbers, *Aero. Res. Counc. Lond. Rep. Mem.* 3090, 13 pp., 1958.

Laminar channel flow over the mouth of a slot is investigated. Stream function is expanded in powers of Reynolds number, and terms of the series are computed by relaxation. Slot pressure at depths greater than slot width exceeds undisturbed pressure by an amount which decreases with increasing Reynolds number.

A. C. Pipkin, USA

3974. Markland, E., The analysis of flow from pipe manifolds, *Engineering* **187,** 4847, 150-151, Jan. 1959.

3975. Nazarov, G. I., Exact solutions of axisymmetric flows of ideal fluids (in Russian), *Prikl. Mat. Mekh.* **20,** 2, p. 388, 1959.

Axisymmetric solutions are represented as definite integrals of two-dimensional complex potentials weighted with special hypergeometric functions. No boundary conditions are considered.

M. V. Morkovin, USA

3976. Taylor, Sir Geoffrey, Flow induced by jets, *J. Aero/Space Sci.* **25,** 7, 464-465 (Readers' Forum), July 1958.

Author presents the stream functions for the induced flow around two- and three-dimensional jets. The work was done during World War II as a part of the well-known fog dispersal program, Project FIDO. Thermal and forced jets issuing from horizontal boundaries and into free space are treated. Basic argument used to find the functions was that the induced flow will result from the entrainment of air through the surface of the jet at a rate proportional to the jet velocity. The flow calculated was that due to an appropriate distribution of sinks along the axis or plane of symmetry of the jet.

C. L. Coldren, USA

3977. Patraulea, N. N., On the deflection of a free jet (in Russian), *Acad. Repub. Pop. Romine, Rev. Mecan. Appl.* **3,** 1, 5-15, 1958.

Paper discusses the movement of a plane incompressible free jet which is deflected by the presence of a vortex (representing schematically the effect of an airfoil), the ordinary assumption that the deflection angle is small being deleted. The problem may be applied to VTOL aircraft using the deflected slipstream principle. As the external fluid is at rest, the jet boundaries are discontinuity (Helmholtz) lines and the problem is solved by means of a conformal mapping of the flow region onto a circle. The complex potential of the flow and the shape of the discontinuity lines are thus determined; then a relation between the vortex circulation and the deflection angle of the jet is found. It is shown that in order to obtain the greatest possible deflection with a given value of the circulation of the vortex (i.e., with a given value of the lift coefficient of the airfoil), this vortex should be placed as close as possible to the lower boundary of the jet. This finding may be of importance for the design of VTOL aircraft.

Other physical aspects are also included in the paper.

L. Dumitrescu, Roumania

3978. Nelson, J. M., and Powers, J. E., How to calculate unsteady-state flow of natural gas in long pipelines, *Oil and Gas J.* **56,** 26, 86-91, June 1958.

Compressible Flow (Continuum and Noncontinuum Flow)

(See also Revs. 3765, 3785, 3914, 3928, 3975, 4008, 4014, 4022, 4034, 4070, 4071, 4073, 4079, 4080, 4082, 4086, 4088, 4114, 4131, 4153, 4181, 4191)

Book—3979. Emmons, H. W. (editor), Fundamentals of gas dynamics (High speed aerodynamics and jet propulsion, Vol. III), Princeton, New Jersey, Princeton University Press, 1958, xiii + 749 pp. $20.

This volume is one of a series which is intended to provide a comprehensive and up-to-date treatment of aerodynamics, propulsion and related topics.

The volume consists of the following sections:

A. The equations of gas dynamics: H. S. Tsien
B. One-dimensional treatment of steady gas dynamics: Luigi Crocco
C. One-dimensional treatment of nonsteady gas dynamics: Arthur R. Kantrowitz
D. The basic theory of gas dynamic discontinuities: Wallace D. Hayes
E. Shock-wave interactions: H. Polachek and Raymond J. Seeger
F. Condensation phenomena in high-speed flows: H. Guyford Stever
G. Gas dynamics of combustion and detonation: Th. von Karman, Howard W. Emmons, Richard S. Tankin and Geoffrey I. Taylor
H. Flow of rarefied gases: Samuel A. Schaaf and Paul L. Chambre

Reviewer feels that the subject volume provides a relatively up-to-date account of many gas dynamic topics. The various authors are authorities in their respective fields and have written lucid accounts. However, several criticisms appear warranted. First, there is not a consistent depth of treatment for the various sections. Section B comprises almost 40% of the volume and goes into considerably more detail than do the other sections. It could well stand alone as a separate and excellent text on one-

dimensional steady flows. Second, there is considerable overlap in some of the derivations and discussions. Discussions of the Rankine-Hugoniot relations is a case in point. Finally, the selection and discussion of subject material is not as up-to-date as was possible. In the past few years, concern with atmospheric re-entry has brought to the fore many problems involving dissociated gases and nonequilibrium flows. Recent problems and developments in these fields are ignored. For example, most recent computations involving air at re-entry conditions are based on Hilsenrath, J., and Beckett, C. W., et al, "Tables of thermodynamic properties of argon-free air to 15,000° K., Arnold Engng. Dev. Center TN 56-12, 1956.

This reference does not appear in the subject volume. Similarly there is no discussion of sound propagation in a relaxing medium. These criticisms are perhaps inevitable for a volume consisting of separate, topical contributions of many authors in fields which are still rapidly growing.

In the main, the volume fills an important need and is highly recommended for both the research worker and the student in gas dynamics.

H. Mirels, USA

Book—3980. Fabri, J., Air intake problems in supersonic propulsion, 11th AGARD Combustion and Propulsion Panel Meeting, Paris, Dec. 1956; New York, Pergamon Press, 1958, xx + 82 pp. $5.00.

A collection of four separate papers on air intake-engine matching problems is edited by J. Fabri.

The first paper, "The role of the air intake in the propulsion balance of a jet engine" by P. Carriere (in French), defines characteristic parameters of air intake of jet engine (mass-flow coefficient, efficiency, drag coefficients) and gives fundamental equations of equilibrium flow and aerodynamic thrust. Specific examples of performance are discussed.

The second paper, "A review of supersonic air intake problems" by D. D. Wyatt (in English), indicates promising solutions of air intake problems (pressure recovery, minimization of drag, flow instability, matching between intake and engine) as determined from research.

The third paper, "Problems related to matching turbojet engine requirements to inlet performances as function of flight Mach number and angle of attack" by A. Ferri (in English), discusses turbojet engine-inlet matching for supersonic flight. While a large number of parameters have to be controlled for exact intake-engine matching, the more important of these are: Mach number ahead of inlet, air temperature, inlet geometry and location.

The fourth paper, "Interpretation of supersonic air intake tests" by L. Viaud (in French), discusses wind-tunnel experimentation on air intakes and factors involved in producing best experimental conditions. In view of the difference in results from various wind tunnels, use of a "standard" air intake is proposed for comparison experiments.

Reviewer believes it would have been more desirable to publish this valuable discussion of air intake-engine matching problems in an English or completely bilingual edition to achieve more widespread dissemination amoung design engineers.

W. L. Haberman, USA

3981. Burley, R. R., and Bryant, L., Experimental investigation of coaxial jet mixing of two subsonic streams at various temperature, Mach number, and diameter ratios for three configurations, *NASA Memo* 12-21-58E, 29 pp., Feb. 1959.

The mixing of two subsonic coaxial gas streams was investigated experimentally over a range of primary to secondary Mach number ratios of 1.00 to 3.00 and primary to secondary temperature ratios of 1.55 to 2.44. Three configurations were investigated. One configuration was designed to give flat velocity profiles, and the other two configurations were designed to give velocity profiles similar to those existing at the inlet of propulsive systems such as afterburners. Curves of axial velocity and temperature profiles across the radius are presented for various axial distances along the mixing zone.

From authors' summary

3982. Axelson, J. A., and Haacker, J. F., Subsonic wing loadings on a 45° sweptback-wing and body combination at high angles of attack, *NASA Memo* 1-18-59A, 57 pp., Feb. 1959.

Experimental pressure distributions and normal-force coefficients are presented for the wing-body combination and for the body with one wing panel only for angles of attack from 0° to 36° at Mach numbers of 0.30 and 0.50. The results are analyzed and correlated with data for other 45° sweptback-wing and body combinations having aspect ratios between 4.0 and 8.0 at the highest angles of attack for which measurements are available.

From authors' summary

3983. Cahn, M. S., An experimental investigation of sting-support effects on drag and a comparison with jet effects at transonic speeds, *NACA Rep.* 1353, 32 pp., 1958.

Various dummy stings were tested on the rear of a related series of afterbody shapes for Mach numbers from 0.80 to 1.10 and Reynolds numbers based on body length from 15.0×10^6 to 17.4×10^6. A method is presented whereby approximate sting interference corrections can be made to models having afterbody shapes and sting supports similar to those of these tests if the Reynolds numbers are of the same order of magnitude and a turbulent boundary layer exists at the model base. Also presented is an analysis of jet duplication by use of a sting.

From author's summary

3984. Nocilla, S., Transonic flows past symmetrical airfoils with attached shock wave ($M_\infty < 1$), Part I, AFOSR TN 58-63 (Lab. Meccanica Applicata Politecn. Torino TN 4; ASTIA AD 148-106), 26 pp., Dec. 1957.

Author assumes a mixed potential flow with a limit line. Limit hodograph, locus of tangencies of streamlines and characteristics, has generally one special point where it is tangent to streamline (map of cusp of limit line) and elsewhere any intersecting streamline meets it twice. Essentially author aims to exclude limit hodograph from flow by cut along a curve through the special point, such that (weak) shock relations are satisfied between points of cut on same streamline. Cut then maps into weak shock (described twice) in a physical plane.

An approximate treatment of local problem of determining cut in neighborhood of special point is given using Tricomi approximation.

Reviewer notes that these assumptions must determine weak shock falling to zero strength within supersonic domain—author's hypothesis—so it must be considered a special case. Reviewer believes that above treatment is equivalent to drawing shock through self-intersections of streamlines in "pleated" physical plane; thus, in general, all streamlines through shock have discontinuous tangents, even profile streamline.

H. C. Levey, Australia

3985. Nocilla, S., Transonic flows past symmetrical airfoils with attached shock wave ($M_\infty < 1$), Part II, AFOSR TN 58-943 (Lab. Meccanica Applicata Politecn. Torino TN 9; ASTIA AD 205-083), 23 pp., July 1958.

Theory of Part I is applied to particular approximate hodograph solution for airfoil shape of Tomotika and Tamatha [*Quart. Appl. Math.* **9**, 2, 129–147, 1951; AMR **4** (1951), Rev. 3956].

Derived profile has discontinuous tangent at shock intersection, as reviewer expects. Reviewer notes that, like all hodograph methods, this is an indirect approach and will only give particular solutions.

H. C. Levey, Australia

3986. Van Tuyl, A., The replacement of lifting surfaces by lifting lines with variable position, *J. Aero/Space Sci.* **26,** 2, 127–128 (Readers' Forum), Feb. 1959.

Author shows how in certain cases of interest the downwash of lifting lines replacing lifting surfaces in supersonic flow is accurate up to terms of the order of $1/x^3$ (where x is the downstream distance). This is an extension of a result of C. Ferrari [AMR **10** (1957), Rev. 4076]. A. G. Fabula, USA

3987. Grodzovskii, G. L., Supersonic axisymmetric conical flows with conical shocks, adjacent to uniform parallel flows (in Russian), *Prikl. Mat. Mekh.* **23,** 2, 379–383, 1959.

Systematic study of conical flows in the hodograph plane disclosed two new families which can be matched to conical shocks and uniform flow (Figs. 2, 3, and 4). In the physical space they correspond to flows through specially formed channels. The analogous problem in unsteady flows has been treated by the author et al in *Prikl. Mat. Mekh.* **23,** 1, 198–200, 1959 (this issue, Rev. 4001). M. V. Morkovin, USA

3988. Maikapar, G. I., On the wave drag of nonaxisymmetric bodies at supersonic speeds (in Russian), *Prikl. Mat. Mekh.* **23,** 2, 376–378, 1959.

Consider pyramidal bodies with starlike cross sections. Author claims that, for any supersonic Mach number M, special bodies of this family generate only plane shock waves stretching between the outer edges of the pyramids. Consequently for this design M, these bodies would produce less shock surface and drag per unit cross-sectional area than the efficient circular cones (Fig. 4).

There is no discussion of stability of the shock configuration nor of the potentially large changes in drag due to small departures from design M, zero angle of attack, or blunting of the edges. M. V. Morkovin, USA

3989. Love, E. S., Supersonic wave interference affecting stability, *NACA TN* 4358, 11 pp. + 15 figs., Sept. 1958.

Paper presents a clear survey of the interference flow fields created by wings, bodies, wing-body combinations, jets and nacelles. For each of these categories, the effect of the several possible interference fields on the stability of aircrafts at supersonic flow is considered. The influence on stability characteristics is elucidated by calculations and illustrations. Interference from vortex flow and viscous effects are neglected.

H. Bergh, Holland

3990. Fabri, J., and Paulon, J., Theory and experiments on supersonic air-to-air ejectors, *NACA TM* 1410, 30 pp., Sept. 1958.

A comparison of experiment with theory is made for air ejectors having cylindrical mixing sections and operating under conditions of supersonic primary flow and either mixed or supersonic regimes of mixing. The effect on ejector performance of such parameters as mixer length and cross section, terminating diffuser, primary Mach number, and primary nozzle position is presented in terms of mass flow and pressure ratio. From authors' summary

3991. Shinyglevskii, Yu. D., A variational problem of gas dynamics of axially symmetrical supersonic flows (in Russian), Avtorefer. Diss. Kand. Fiz.-matem. Nauk, Matem. In-ta Akad. Nauk SSSR, Moscow, 1957; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11355.

3992. Hunter, P. A. An investigation of the performance of various reaction control devices, *NASA Memo* 2-11-59L, 37 pp., Mar. 1959.

Tests were made in still air utilizing both subsonic and supersonic internal flows. The range of nozzle total-exit-pressure ratio covered was from approximately 1.3 to 6.5. The specific parameters investigated were the ratio of lateral force to resultant force of the undeflected jet, the ratio of resultant force to resultant force of the undeflected jet, and the ratio of weight flow referred to the weight flow of the undeflected jet.

From author's summary

3993. Messiter, A. F., A similarity law for the normal force on a delta wing at hypersonic speeds, *J. Aero/Space Sci.* **26,** 2, 119–120 (Readers' Forum), Feb. 1959.

Author calculates normal force coefficient on a thin wing at angle of attack in inviscid hypersonic flow. Order of magnitude arguments and similarity conditions are imposed to reduce the four-parameter problem to a one-parameter problem.

Author states that available data can be well correlated by the formula derived. H. A. Stine, USA

3994. Lunev, V. V., On the similarity of hypersonic viscous flow around slender bodies (in Russian), *Prikl. Mat. Mekh.* **23,** 1, 193–197, 1959.

Usage of curvilinear coordinates for two-dimensional and axisymmetric hypersonic flows of a viscous (viscosity $\mu \approx n$th power of enthalpy i), heat-conducting perfect gas around slender bodies (viscous layer $\delta \ll$ body length, L; $L \ll$ radius of curvature of profile, R) allows a systematic order-of-magnitude analysis which still leads to the usual boundary-layer equations and small pressure changes across the layer. Classification of possible subcases establishes the general formula $\delta/l \sim \chi[M_\infty(1 + M_\infty\beta + \chi^{1/2})]^{-1}$, where χ is proportional to $M_\infty^{2+n}/\sqrt{Re}$, and β is the thickness ratio. With the exception of an "unimportant" region near the edge of the viscous layer, the whole flow field, given by the system of dimensionless hypersonic equations for the interacting outer inviscid flow between the shock and the edge of the boundary layer and inner viscous layer, is then shown to depend only on the external parameters χ and $M_\infty\beta$ and on the dimensionless surface distributions of enthalpy and body geometry.

M. V. Morkovin, USA

3995. Charwat, A. F., On the contribution of thermal creep to the skin friction in slip flow, *J. Aero/Space Sci.* **26,** 2, 120–121 (Readers' Forum), Feb. 1959.

Author estimates wall shear and slip velocity for flow of rarefied fluid past semi-infinite plate with nonuniform temperature. In particular, the contribution of the streamwise temperature gradient to "slip" velocity boundary condition at wall (i.e. thermal creep) is included. Solution is obtained by considering special wall temperature distribution which permits analytical solution of equivalent Rayleigh problem (impulsive motion of infinite plate). Wall shear and slip velocity for a semi-infinite flat plate are then estimated from analogy with the Rayleigh problem.

H. Mirels, USA

3996. Shirokov, M. F., Velocity and temperature discontinuities near the walls of a body around which rarefied gases flow with transonic velocities, *Soviet Phys.—JETP* **7,** 6, 1029–1032, Dec. 1958. (Translation of *Zh. Eksper. Teor. Fiz.* **34,** 6, 1490–1495, June 1958 by Amer. Inst. Phys., New York, N. Y.)

New and more general formulas are derived for velocity and temperature discontinuities on a gas-wall surface for rarefied gas flows of arbitrary Mach number. The equation for the velocity discontinuity is almost the same as that for very low Mach numbers; on the other hand, the relation for the temperature discontinuity differs markedly from the well-known Maxwell formula for a gas at rest near a wall. R. C. Binder, USA

3997. Kogan, M. N., On the equations of rarefied gas flows (in Russian), *Prikl. Mat. Mekh.* **22,** 4, 425–432, 1958.

Author presents a simple derivation of the linearized Boltzmann equation, emphasizing the assumptions which are necessary for

that purpose, i.e. (1) that the repulsive forces acting in the molecular encounters vary in accordance to Maxwell's law, that is proportional to $1/r^5$ and (2) that the relaxation time for the gas molecules is of the order of the interval between two collisions, that is after one collision, in the mean, the distribution function for the gas molecules takes the equilibrium (Maxwell) form. This last assumption is fairly close to actuality.

A general solution of the linearized Boltzmann equation is then given, which extends Enskog's series and allows the evaluation of the residual term to be made in cases when Enskog's series fails to converge (e.g., within strong shock waves).

The relations between the macroscopic flow parameters deduced by using the above solution differ only by proportionality constants from the exact solutions. For instance, in the Navier-Stokes approximation obtained from the linearized equation the ratio between the viscosity and conductivity coefficients is $\lambda/\mu = 5/2\,(k/m)$ while in the exact theory the ratio is $\lambda/\mu = 15/4\,(k/m)$.

L. Dumitrescu, Roumania

3998. Gundersen, R., A note on shock flow in a channel, *J. Fluid Mech.* **4,** 5, 501–504, Sept. 1958.

Author obtains, as an extension of his previous paper [*J. Fluid Mech.* **3,** 6, p. 553, Mar. 1958], a relation in closed form between shock strength and channel area for the case of a shock wave moving into a channel of slowly varying cross section. The shock itself is generated by uniform compressive motion of a piston. The shock strength-channel area relationship is compared with that obtained by R. F. Chisnell [AMR **10** (1957), Rev. 4083] for the case of a shock wave passing through a two-dimensional channel consisting of two uniform cross sections joined by a section of slowly varying area. In an application to cases of converging cylindrical and spherical shocks, it is shown that reflected perturbations from the piston have an effect of reducing the ultimate shock strength.

A. Ritter, USA

3999. Konotorovich, V. M., Stability of shock waves in relativistic hydrodynamics, *Soviet Phys.-JETP* **7,** 1, 127–132, July 1958. [Translation of *Zh. Eksp. Teor. Fiz.* **34,** 1, 186–194, Jan. 1958 by Amer. Inst. Phys., Inc., N. Y.]

Stability against small perturbations of the discontinuity surface is investigated for shock waves in an arbitrary medium, described by relativistic equations for an ideal fluid.

From author's summary

4000. Kleiman, Ia. Z., On the propagation of strong discontinuities in a multi-component medium, *J. Appl. Math. Mech. (Prikl. Math. Mekh.)* **22,** 2, 268–278, 1958. (Reprint order no. PMM 22, Pergamon Press, 122 E. 55th St., New York 22, N. Y.)

Author considers the kinds of discontinuities admitted by ideal (inviscid) compressible flow equations for a multi-phase medium with noninteracting components. This problem is of interest in connection with the mechanics of systems ranging from water-sand mixtures to liquid fuel-air mixtures. Attention is restricted to n-component systems in which intercomponent diffusion is negligible; e.g. multi-component gas mixtures are excluded. Assuming that the pressure is the same within each phase, the equations for the conservation of mass and momentum of each component at a discontinuity are effectively written in terms of the densities, velocities, and mass fractions of each component and the pressure on each side of the discontinuity. Author's analysis of these relations is largely qualitative for strong discontinuities and quantitative for weak shock waves.

In addition to the analogues of shock waves, contact discontinuities, and slip discontinuities of one-component systems, a number of other kinds of discontinuities can exist in n-component mixtures. Author demonstrates the existence and properties of shock waves containing slip discontinuities with respect to some components and of constant-pressure discontinuities with a normal flow of some components. It is shown that as many as $2n$ different sound velocities may exist for an n-component mixture. For a two-component system explicit expressions for these velocities are obtained in terms of the properties of the mixture upstream from the discontinuity. As the mass fraction of one component is changed from zero to unity, the sound speed varies monotonically. For a mixture of a dense substance with a high sound speed (solid or liquid) and a light substance with a low sound speed (gas), a very small volume concentration of gas will nearly reduce the sound speed of the mixture to that of the gas.

F. A. Williams, USA

4001. Grodzovskii, G. L., Diakolov, A. N., Tokarev, V. V., and Tolstykh, A. I., Self-similar motions of gas with shock waves, spreading with constant speed into gas at rest (in Russian), *Prikl. Mat. Mekh.* **23,** 1, 198–200, 1959.

In the framework of strong blast-wave theory with cylindrical symmetry (similar to that of S. C. Lin, *J. Appl. Phys.* **25,** Jan. 1954), numerical integration of the two resulting nonlinear differential equations leads to results displayed in the "phase plane," in the time-position plane, and in the plot of pressure, density, particle velocity vs. axial distance, all nondimensionalized with respect to the corresponding quantities just behind the shock. Four types of physically realizable motion obtain, depending upon whether the shock is converging or diverging, and moving away or into the gas at rest. These motions are also interpreted in the corresponding stationary hypersonic flows with diverging and converging stream tubes. In particular, excellent check of the blast analogy with exact conical results is shown.

M. V. Morkovin, USA

4002. Pogodin, Iu. Ia., Suchkov, V. R., and Ianenko, N. N., On travelling waves of gas dynamic equations, *J. Appl. Math. Mech. (Prikl. Math. Mekh.)* **22,** 2, 256–267, 1958. (Reprint order no. PMM 21, Pergamon Press, 122 E. 55th St., New York 22, N. Y.)

A complicated formalism is given for finding wave solutions of sets of m first order, quasi-linear, partial differential equations in m unknowns and m independent variables. A wave of rank r is defined as a solution involving r arbitrary functions presumably determined by the boundary conditions. Examples are given from unsteady two-dimensional gas dynamics ($m = 3$). In this context, the plane waves familiar from one-dimensional flow are waves of rank 1. The region of interaction of two plane waves is a wave of rank 2. Irrotational flows and conical flows are examples of waves of rank $(m - 1)$.

C. M. Ablow, USA

4003. Ehlers, F. E., and Shoemaker, E. M., A linearized analysis of the forces exerted on a rigid wing by a shock wave, *J. Aero/Space Sci.* **26,** 2, 75–80, 107, Feb. 1959.

Problem of a wing struck by a plane shock is idealized by replacing the wing by a rigid half plane. The shock is assumed to be parallel to the leading edge of the half plane representing the wing. The flow field thus obtained has two space coordinates and the time as independent variables. By a similarity transformation the number of independent variables is reduced to two. With the assumption of small perturbations and by a Buseman transformation one arrives at a boundary-value problem for Laplace's equation which is solved completely by techniques of conformal mapping. Solutions are given for subsonic and supersonic speeds of the wing. Also the flow over a stationary wedge can be treated.

K. G. Guderley, USA

4004. Dewey, C. F., Jr., Transient analysis of a two-chamber blowdown process with critical flow, *J. Aero/Space Sci.* **26,** 1, 62–63 (Readers' Forum), Jan. 1959.

Expressions are derived for transient conditions associated with reservoir discharging high-pressure gas through receiver into at-

mosphere. Analysis assumes critical flow in throats with zero heat transfer although author suggests this can be added as refinement. Numerical evaluation is required in general case, although analytic solution is given for small transient time. Reviewer believes that heat transfer is important in most practical applications and therefore general method is limited in usefulness. However, solution for small transient time is of help in preliminary analyses of two-chamber problems.

F. G. Blight, Australia

4005. Grigorian, S. S., Cauchy's problem and the problem of a piston for one-dimensional, non-steady motions of gas (automodel motion), *J. Appl. Math. Mech. (Prikl. Math. Mekh.)* **22,** 2, 244–255, 1958. (Reprint order no. PMM 20, Pergamon Press, 122 E. 55th St., New York 22, N. Y.)

Limitations on physical flows representable by the self-similar (automodel) solution are qualitatively discussed. The self-similar model reduces the equations of nonsteady isentropic flow of a perfect gas to an ordinary differential form. Author considers isoclines of this equation, with attention to effect of parameters, singular points and limiting lines, determining the properties of integral curves in general. Particular cases, such as strong explosions or flows driven by a piston expanding spherically in accordance with a power-law rate, must share these properties and, in addition, satisfy special conditions: the shock relation, or the velocity imposed at the piston. It is shown by appeal to graphical description that, in general, the properties of the integrals and the special conditions are incompatible.

R. A. Stern, USA

4006. Ryhming, I., Unsteady supersonic flow through cascades of airfoils including upstream effects (in German), *ZAMM* **37,** 11/12, 416–430, Nov./Dec. 1957.

The stationary flow through a supersonic cascade with upstream effects into the guide vanes has been treated in a previous paper. If the relative velocity between rotor and guide vanes is taken into account, nonstationary phenomena emerge which may be classified as quasi-stationary and nonstationary proper, respectively. The quasi-stationary phenomena, which are the more important ones from a practical point of view, may be treated in much the same way as the stationary ones. Hence the main portion of the present investigation is devoted to the nonstationary phenomena proper.

From author's summary

4007. Coburn, N., The method of characteristics for a perfect compressible fluid in general relativity and non-steady Newtonian mechanics, *J. Math. Mech.* **7,** 4, 449–481, July 1958.

Author's previous analysis of the characteristic equations for steady supersonic flow in three dimensions is extended to relativistic fluids. In the space time of general relativity the characteristic coordinate system is based on two families of bicharacteristic curves and two families of curves formed by the intersection of characteristic surfaces. The equations of motion referred to these coordinates, called the second characteristic equations, are derived in full. The relativistic equations are reduced, using the usual first approximation technique, to equations of unsteady flow of a compressible fluid in Newtonian mechanics. As a result of this excellent work the equations of gas dynamics are now known in a very general form, and a wide range of problems, particularly those of cosmological interest, can be formulated mathematically.

M. Holt, USA

Boundary Layer

(See also Revs. 3941, 4081, 4086, 4101, 4116, 4159, 4188, 4240)

4008. Sibulkin, M., A note on turbulent boundary layer growth in nozzles, *ARS J.* **29,** 1, 61–63 (Tech. Notes), Jan. 1959.

A two-dimensional compressible turbulent boundary-layer calculation to find the effect of the momentum thickness of the boundary layer at the throat on the thickness at the exit in a supersonic nozzle. It is found that, if the throat layer is thin, changes in its thickness have little effect on the exit thickness. This seems to be the usual case in practice. If the throat layer is thick the exit thickness approaches direct proportionality with the throat thickness. Method of calculation uses parameters with values given by Tucker, AMR 4 (1951), Rev. 823.

J. C. Cooke, England

4009. Bandettini, A., and Isler, W. E., Boundary-layer-transition measurements on hemispheres of various surface roughnesses in a wind tunnel at Mach numbers from 2.48 to 3.55, *NASA Memo* 12-25-58A, 29 pp., Mar. 1959.

Wind-tunnel tests have been made to determine the location of transition of the boundary layer on three separate hemispheres having absolute surface roughness values of 50, 580, and 2760 microinches. The tests were in the range of Reynolds numbers, based on the 19-inch hemisphere diameter, from 1.5 to 7.5 million. Transition location was determined from shadowgraphs and checked by local temperature-recovery measurements.

From authors' summary

4010. Jones, R. A., An experimental study at a Mach number of 3 of the effect of turbulence level and sandpaper-type roughness on transition on a flat plate, *NASA Memo* 2-9-59L, 43 pp., Mar. 1959.

An optical method was used to study the effect of turbulence level and sandpaper-type roughness on transition for a flat plate at a Mach number of 3 with no heat transfer. A range of roughness Reynolds number and a range of roughness height to boundary-layer displacement thickness which moved transition less than 10 percent were found and were functions of turbulence level.

From author's summary

4011. Kuehn, D. M., Experimental investigation of the pressure rise required for the incipient separation of turbulent boundary layers in two-dimensional supersonic flow, *NASA Memo* 1-21-59A, 48 pp., Feb. 1959.

An experimental investigation has been made for two-dimensional compression corners, curved surfaces, and incident-shock models. The tests were conducted over a range of Reynolds numbers, based upon boundary-layer thickness, from 1.5×10^6 to 7.5×10^6 and Mach numbers from 1.6 to 4.2. Results show that Mach number, Reynolds number, and model shape all are important variables affecting the pressure-rise ratio for incipient separation. Observations were also made of the degree of unsteadiness associated with various separated flows when the conditions for incipient separation had been exceeded.

From author's summary

4012. James, C. S., Boundary-layer transition on hollow cylinders in supersonic free flight as affected by Mach number and a screwthread type of surface roughness, *NASA Memo* 1-20-59A, 49 pp., Feb. 1959.

Test Mach numbers were between 2.8 and 7 with a unit Reynolds number of 3 million per inch. Model surfaces were cold relative to stagnation temperatures. Transition Reynolds number was found to increase with Mach number throughout the range tested. Roughness required to influence transition increased with Mach number. Certain optimum roughnesses were found which permitted longer laminar runs than did a smooth surface.

From author's summary

4013. Tatsumi, T., and Kakutani, T., The stability of a two-dimensional laminar jet, *J. Fluid Mech.* **4,** 3, 261–275, July 1958.

The stability of a two-dimensional laminar jet for infinitesimal antisymmetric disturbances is studied. For the upper part of the

neutral stability curve the solution of the Orr-Sommerfeld equation is developed in negative powers of αR, and for the lower part, in positive powers of αR. The critical Reynolds number obtained is of the order of 4, and hence too small for the flow to be considered as parallel locally. The result is therefore not strictly valid for prediction of instability. Nevertheless, the order of magnitude of the critical Reynolds number should be correct, and the information obtained is valuable. C.-S. Yih, USA

4014. Trilling, L., Oscillating shock boundary-layer interaction, *J. Aero/Space Sci.* **25,** 5, 301-304, May 1958.

A simple model of the interaction of an oscillating shock wave with a laminar boundary layer is proposed. It involves a small perturbation of the steady interaction pattern found by Chapman, Larson, and Kuehn, AMR **11** (1958), Rev. 186, and Hakkinen, Greber, Trilling, and Abarbanel, MIT, FDRG Rep. 57-1, 1957. It is found that for any local Mach number above 1.5 and for any Reynolds number there is a combination of frequency and shock strength for which shock oscillations are neutrally stable. In particular, normal shocks reach the stability threshold when the local upstream Mach number is between 1.57 and 1.65, depending on the Reynolds number. A viscous interaction mechanism of this type may play a role in exciting transonic buffeting and buzz.

From author's summary by J. C. Rotta, Germany

4015. Speidel, L., Influencing the laminar boundary layer through periodic disturbances by injections (in German), *Z. Flugwiss.* **5,** 9, 270-275, Sept. 1957.

The effect of a periodic disturbance of the free stream on the laminar boundary layer is investigated. The disturbance is generated by a wire oscillating across the free stream. The effect on the boundary layer is measured immediately by the change of the coefficient representing the fluid resistance of a profile. If the free stream is periodically disturbed, the resistance is essentially affected by the Strouhal number. The drag which, for very small values of the Strouhal number, is practically equal to that of the undisturbed flow, increases with the Strouhal number and approaches asymptotically the drag in fully turbulent flow. The results obtained from experiments with laminar boundary layers of various types of stability can be correlated in a diagram by using appropriate choice of the parameters for the Strouhal number.

From author's summary

4016. Escande, L., On some possibilities of changing the flow characteristics in hydraulic structures by boundary layer suction (in Roumanian), *Studii Si Cercetari Mecan. Appl.* **9,** 3, 559-594, 1958.

Paper discusses several cases of stream separation which may take place in hydraulic structures, and presents effective solutions for avoiding negative effects. These solutions consist in the boundary-layer suction within the regions where this phenomenon occurs. Thus the use of collecting and evacuating suction slots on a spillway crest eventually contributes to the improvement of flow conditions. The same method is applied to a take-off situated at the point of the water deviation from a river and to flows through diffusers and around pillars.

D. Gh. Ionescu, Roumania

4017. Appleton, J. P., and Davies, H. J., A note on the interaction of a normal shock wave with a thermal boundary layer, *J. Aero/Space Sci.* **25,** 11, 722-723 (Readers' Forum), Nov. 1958.

In a paper "Interaction of a shock wave with a thermal boundary layer" by W. C. Griffith [AMR **9** (1956), Rev. 1873], two partial differential equations for the pressure perturbation and the perturbation in the component of the velocity normal to the wall are derived. These equations reduce to the Cauchy-Riemann equations by defining a set of reduced coordinates. Authors of this note obtain the solution by introducing a complex function $W = p^* + iv^*$. Their result is compared with Griffith's approximate solution and his experiments.

Irmgard Flugge-Lotz, USA

Turbulence

(See Revs. 4008, 4102, 4107, 4237, 4246, 4258, 4259)

Aerodynamics

(See also Revs. 3723, 3765, 3781, 3973, 3977, 3986, 4066, 4069, 4083)

4018. Collar, A. R., On the accuracy of the representation of a lifting line by a finite set of horseshoe vortices, *Aero. Quart.* **9,** 3, 232-250, Aug. 1958.

Formulas are derived for calculating the induced downwash from the given strengths of vortices when the lifting surface is represented by a finite set of horseshoe vortices, and, vice versa, formulas are presented for the calculation of the strengths of vortices for the downwash given at certain points of the lifting line, especially in the centers of horseshoe vortices.

Numerical results obtained on the basis of these formulas are compared with well-known exact solutions for the case of an elliptic (symmetric) loading and an antisymmetric loading. It follows from this comparison that for the determination of the strengths of vortices, it is most convenient to specify the induced downwash at the center of each vortex. For the error not to exceed 5%, at least 20 vortices are required for a symmetric distribution and 40 vortices for an antisymmetric distribution. Correction factors are derived for both cases.

The same applies for the case when the strengths of the vortices are determined by geometric incidence modified by downwash; here the error is smaller than in the previous case and is also affected by the aspect ratio.

J. Polasek, Czechoslovakia

4019. Jones, E. E., The forces on a thin aerofoil in slightly parabolic shear flow (in English), *ZAMM* **37,** 9/10, 362-370, Sept./Oct. 1957.

Aerodynamic characteristics of the Joukowsky-type thin airfoil exposed in a nonviscous shear flow with slightly parabolic velocity distribution are investigated by solving a linear perturbation equation for the stream function. The solution is derived in a series expansion of the modified Mathieu functions. The treatment is exact to the first order of the velocity profile curvature. Lift, drag and moment of the airfoil are obtained in closed forms. Negative drag appears in case of the velocity increasing outward from the symmetry axis.

R. Kawamura, Japan

4020. Castles, W., Jr., Flow induced by a rotor in power-on vertical descent, *NACA TN* 4330, 16 pp. + 3 tables + 6 figs., July 1958.

Approximate equations are derived for the induced power required and blade loading of a lifting rotor operating in the power-on vertical-descent range. The approximate relations, which are based upon certain assumptions as to the nature of the flow pattern, yield, for the induced power variation, results which are in general agreement with the available experimental data.

As there are no experimental blade-load or direct induced-velocity measurements available for comparison, some judgment should be exercised in the application of the theoretical blade-load equations given in the paper.

It might be pointed out that the present analysis gives no steady-state solution for the (hypothetical) rotor with uniform disk loading operating in the power-on descent range where the ratio of the free-stream velocity to the induced velocity in hovering is greater than the square root of 2. In the case of any actual lifting rotor the disk loading will go to zero at the hub and the radial distribution of disk loading will be dependent upon the rate of descent. Consequently, it might be expected that the range of stable operation for any actual rotor will be larger than that for the hypothetical case of uniform loading.

L. Goland, USA

4021. Tipei, N., Unsteady motion of an airplane flying on a horizontal path (in Russian), *Acad. Repub. Pop. Romine, Rev. Mecan. Appl.* **3,** 3, 199-213, 1958.

Author writes the general motion and equilibrium equations and, by using certain transforms which include some negligible approximation, reduces the problem to the solving of a first-order differential equation for the airplane velocity with respect to time. The method is developed both for propeller and jet airplanes. Applications are made to various evolutions: horizontal path effectuated under constant incidence, accelerated motions on curved paths, paths effectuated under a constant angle of lateral wing inclination, motions under constant tangential acceleration, motions effectuated under a given variation in time of the lateral wing inclination. For all these evolutions, the variation of the airplane velocity with respect to time as well as of the other motion parameters is given.

V. N. Constantinescu, Roumania

4022. Fraenkel, L. E., A note on the drag of wing-body combinations in linearised supersonic flow, *Aero. Quart.* **9,** 3, 305-312, Aug. 1958

An extension is sought of Ward's result concerning drag of wing-body combinations by choosing a more general expression for body source strength suggested by the quasi-cylinder solution. By neglecting influence of multi-sources and of some of interference fields, an expression is established for the drag of wing-body combinations which are neither slender nor smooth, but have small profile slopes. Its application to actual problems may prove to be a difficult one.

A. von Baranoff, France

4023. Squire, W., Some comments on generalized trajectories for free falling bodies of high drag, *Jet Propulsion* **28,** 12, 838-839 (Tech. Notes), Dec. 1958.

Author presents a rapid graphical method to calculate trajectories for free falling bodies, using an exponential atmosphere and a constant drag coefficient. The method is based on an analysis by Munk (1944).

J. Roskam, USA

4024. Boisseau, P. C., Low-subsonic static stability and damping derivatives at angles of attack from 0° to 90° for a model with a low-aspect-ratio unswept wing and two different fuselage forebodies, *NASA Memo* 1-22-59L, 25 pp., Mar. 1959

Results of force tests made at low Reynolds numbers are presented for a fuselage configuration having a long pointed nose and a shorter rounded nose. These forebodies were tested because preliminary data indicated that the pointed nose caused large variations in the lateral-stability data above an angle of attack of 40°. The results include data for the complete model and for the model with both vertical and horizontal tails removed.

From author's summary

4025. Eggleston, J. M., and Phillips, W. H., A method for the calculation of the lateral response of airplanes to random turbulence, *NACA TN* 4196, 27 pp. + 1 table + 4 figs., Feb. 1958.

Conventional analyses of gust effects assume gust-velocity distributions equivalent to rigid-body motions. *NACA TN* 3954 determines responses more precisely, using forces and moments from gusts in power-spectral form in terms of horizontal, vertical, and side components of gust velocity. Authors here use typical power spectral descriptions of gusts to determine complex stability derivatives which include random distribution of side gusts along fuselage and tail and penetration effects. Rolling and yawing gusts are defined in terms of random distributions across the span. A calculation procedure is tabulated for determining in power spectral form the lateral response.

E. T. Welmers, USA

4026. Pinsker, W. J. G., Critical flight conditions and loads resulting from inertia cross-coupling and aerodynamic stability deficiencies, *Aero. Res. Counc. Lond. Curr. Pap.* 404, 44 pp., 1958.

The effects of the gyroscopic forces on aircraft with large inertias during rolling maneuvres are discussed, and criteria are given for the three resulting divergent flight conditions: yaw divergence, pitch divergence and autorotational rolling. The critical loading cases in practical rolling maneuvres are discussed and methods for the determination of peak loads outlined.

Aircraft responses in inadvertent pitch-up are analyzed, and data are given for the estimation of peak loads both for uncontrolled conditions and for pitch-up with pilot's counteraction.

The principal causes for loss of directional stability are indicated and possible dangerous flight conditions are outlined.

From author's summary

4027. Creer, B. Y., Stewart, J. D., Merrick, R. B., and Drinkwater, F. J., III, A pilot opinion study of lateral control requirements for fighter-type aircraft, *NASA Memo* 1-29-59A, 44 pp., Mar. 1959.

In the investigation both a fixed and a rolling simulator were used and actual flight tests were made. The results of this study were the determination of two fundamental parameters which affect pilot opinion of the aircraft roll performance. In addition, a handling qualities criterion was formulated for the lateral control of fighter aircraft flying in their combat speed range.

From authors' summary

4028. Jackson, C. E., and Wherry, J. E., A comparison of theoretical and experimental loads on the B-47 resulting from discrete vertical gusts, *J. Aero/Space Sci.* **26,** 1, 33-45, Jan. 1959.

A dynamic analysis of the structural response of the B-47 airplane to a discrete vertical gust is presented along with comparisons of the results with flight test data. A chosen mode approach is utilized and finite difference equations suitable for high-speed digital computation are given. The analysis contains a number of aerodynamic refinements. The specific responses considered are the peak shear loads and bending moments. Results obtained indicate that the structure vibrations produced large effects on the responses, particularly for the outboard stations. In general, the predicted peak loads are in good agreement with the measured results, although some differences are noted.

This reviewer considers the paper a significant contribution in demonstrating the reliability of dynamic analysis techniques for the calculation of load responses to gust disturbances. The extension of such comparisons to the case of continuous turbulence is needed.

H. Press, USA

4029. Fine, M., A random distribution of gusts corresponding to a measured frequency of vertical gusts, *Aero. Quart.* **9,** 3, 251-257, Aug. 1958.

The frequency distribution of resultant gust velocity component in a vertical propeller plane is calculated from a known frequency

distribution for the vertical component of velocity in this plane. A random distribution of gusts in space is assumed. Resultant planar velocities of 10 fps or more are found to occur 2.51 times as often as vertical components of 10 fps or more. For higher speeds, the ratio is larger.

R. F. Smiley, USA

Fluid Machinery

(See also Revs. 4006, 4020, 4029, 4128)

4030. Kruger, H., A method for the pressure calculation in straight and radial cascades of airfoils (in German), *Ing.-Arch.* **26**, 4, 242–267, Aug. 1958.

For straight cascades, profile contours are assumed to be cubic parabolas. Birnbaum's well-known procedure is then extended: normal velocities v are quadratic functions of abscissae, and tangential velocities u, corresponding to $v = 1, x, x^2$, are determinable by conformal mapping of the cascade into a circle. For radial cascades, a previous logarithmic mapping is needed.

This technique is useful only if a complete set of tables of aforementioned u's is available for different stagger angles β and different chord-pitch (t/l) ratios. Paper gives some of them for $t/l = 0.5, 1, 1.5, 2, \infty$ and $\beta = 90°, 120°, 135°, 150°$.

G. Moretti, USA

4031. Stenning, A. H., Seidel, B. S., and Senoo, Y., Effect of cascade parameters on rotating stall, *NASA Memo* 3-16-59W, 33 pp., Apr. 1959.

Further analysis of the vortex model proposed by Kriebel, Seidel, and Schwind shows that this representation of rotating stall satisfies, at least approximately, the requirements at the cascade. A numerical analysis of vortex trajectories suggests that the stability requirements of the vortex street do not determine stall-cell size. The effects of cascade-parameter variation on rotating stall have been investigated in a circular cascade and single-stage compressor. No substantial changes in the stall pattern were observed. By modification of the single-stage compressor, it has been found possible to stop the rotating-stall pattern and observe the pressure and velocity distribution around the annulus. From authors' summary

4032. Blackwell, B. D., Some investigations in the field of blade engineering, *J. Roy. Aero. Soc.* **62**, 573, 633–646, Sept. 1958.

4033. Wong, R. Y., and Monroe, D. E., Investigation of a 4.5-inch-mean-diameter two-stage axial-flow turbine suitable for auxiliary power drives, *NASA Memo* 4-6-59E, 25 pp., Mar. 1959.

The effect of size on overall turbine performance is investigated. Comparison with theoretical efficiencies based on a loss coefficient and velocity diagrams are presented. Close agreement between theoretical and experimental efficiency was obtained when the loss coefficient was adjusted for Reynolds number changes to the $-1/5$ power. From authors' summary

4034. Wong, R. Y., and Monroe, D. E., Effect of stator and rotor aspect ratio on transonic-turbine performance, *NASA Memo* 2-11-59E, 27 pp., Feb. 1959.

The stator aspect ratios covered were 1.6, 0.8, and 0.4, while the rotor aspect ratios investigated were 1.46 and 0.73. The observed variation in turbine design-point efficiency was negligible. Thus, within the range of aspect ratio investigated, these results verify for turbines operating in the transonic flow range the finding of a reference report, which showed analytically that if blade shape and solidity are held constant the aspect ratio may be varied over a wide range with little effect on overall turbine performance. From authors' summary

4035. Chaplygin, E. N., An analytical expression for the investigation of the lines of constant opening of propeller and radial axis turbines (in Russian), *Trudi Mosk. Energ. In-ta* no. 19, 353–359, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12715.

A procedure is put forward for the formulation of the racing characteristic, on the basis of the usual universal characteristic of the turbine. Paying attention to the fact that when the controlling apparatus is constantly open the relation $N = f(H)$ with n = const represents a straight line intersecting the axis of pressure at a point corresponding to the pressure of idle running, it is possible to carry over the lines of constant opening into the field of the reverse characteristic. Making use of the principle of similarity and introducing the Morozov-Moodie coefficient, for nonmodelling characteristics, author finds the expression $N_1' = An_1' - B(n_1')^3$ which, if the constant coefficients are known, permits the construction of the corresponding curve $N_1' = f(n_1')$.

Experiments carried out on a K 70 rotor with a straight axis suction pipe agree well with the analytical curve. At two points—idle running and some arbitrary point—constants A and B can be determined, and, after investigating the deduced equation to its maximum, an equation is found by means of which it is possible to determine the speed when the turbine is racing, at any degree of opening, to ascertain the magnitude of pressure in idle running, and to deduce the equation for the curve of constant opening on the operational characteristic of a propeller turbine.

I. I. Orlov
Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4036. Voitashevskii, D. A., Optimum regime conditions for the operation of a propeller hydroturbine (in Russian), *Trudi Vses. N.-i. In-ta Gidromashino-str.* no. 19, 2–19, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12716.

Starting from data in previous works of the author on expressions for the hydraulic efficiency obtained by means of the coefficient of hydraulic loss φ and the coefficient of ideal pressure ϵ, author explains some properties of the optimum operational conditions for the turbine.

Earlier it was shown that the hydraulic efficiency is $\eta = 1/(1 + \varphi/\epsilon)$. Consequently, a maximum for η corresponds to a minimum for φ/ϵ. With a fixed angle in the blade assembly of the rotor this relation depends on two kinematic parameters, by means of which the conditions of operation of the turbine are determined. Assuming that the coefficients of loss in the zone of each of the basic working members depend on only one argument characterizing the direction of flow in that member, and finding the maximum value for η, author obtains data for explaining some of the fundamental properties of the optimum conditions for the turbine.

Author investigates the influence of the geometry of the working members of the turbine on the optimum conditions. It is established that the replacement of the suction tube may have a practical bearing because of some disturbance of the optimum conditions along the radius leading from the beginning of the coordinates. The disturbance occurs toward the place of minimum discharge and is accompanied by a diminution in the opening of the controlling apparatus, should the coefficient of loss of the new suction tube be greater than in the former one.

Change in the number and shape of the blades of the controlling apparatus affects the position of the optimum conditions in the same way as in the case of replacement of the suction tube. Increase on the rotor (without alteration of the bushing) of the number of identical and identically positioned blades leads to some decrease of optimum discharge and decrease in the optimum opening of the control apparatus. The influence of the angle of blade

fixing is that when they are turned toward closure the optimum discharge and the optimum opening decreases and vice versa. An increase of the diameter of the bushing with a corresponding cutting down of root portions of the blades is the equivalent of a turn of the blades toward the closing of the opening and leads to the decrease of the optimum discharge. The question is analyzed of the solution of the direct and reverse problems of the theory of the hydroturbine with the aid of the equations proposed by the author.

D.-G. A. Butaev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4037. Cherkasov, B. A., Secondary losses and their influence on the characteristics of the turbine stages (in Russian), *Trudi Mosk. Aviats. In-ta* no. 68, 42–60, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12599.

In building up the calculation characteristics of gas turbines it is assumed that the parameters of the gas on the mean diameter of the blade rim are dependent on the total flow of gas through the turbine stages. In making this assumption a big divergence occurs between the calculated and experimental characteristics, which is explained by the influence of secondary losses, which greatly exceed the profile losses of the uncalculated regimes. The greatest specific weight is possessed by the secondary losses brought about by the radial cross-currents and diffusion flows in the channels of the rotor at the blade roots. They basically depend on the design of the blades. For the correct evaluation of all secondary losses it is essential to go over from tests of plane cascades to tests of circular grid cascades with the introduction of average parameters for the flow and the coefficients of velocity. Some experimental material is put forward for secondary losses and averaged parameters, the availability of which permits the speeding up of the solution of the problem of the analytical determination of the characteristics of gas turbines.

T. A. Filippova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4038. Gross, S. A., Analytical method of determining the conditions of operation of centrifugal pumps (in Russian), *Gidrotekh. Stroit.* no. 10, p. 57, 1956; *Ref. Zh. Mekh.* no. 11, 1957; Rev. 12722.

The calculation is demonstrated of the conditions of operation of a centrifugal pump; the calculation leads to the solution of the equation of the characteristics of a centrifugal pump and the equation of the hydroanalytic characteristics of the associated conduits.

Yu. A. Lashkov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4039. Lenherr, F. E., Reynolds number effect on small-engine compressor performance, *J. Aero/Space Sci.* **25**, 9, 597–598 (Readers' Forum), Sept. 1958.

4040. Novozhilov, S. Ya., Peculiarities of the hydraulic calculations of multi-stage ships' condenser pumps by the method of similarity (in Russian), *Sudostroenie* no. 9, 10–12, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12721.

The special features in the hydraulics calculations for condenser pumps are investigated by comparison with the calculations for centrifugal pumps for other purposes. It is indicated that, when making calculations for condenser pumps by the method of similarity, besides ensuring the specified output and pressure, it is essential to guarantee the conservation of the cavitation characteristics of the model, determinable by the value of the cavitation coefficient of high speed. The last difficulty involves separate calculations for the first and subsequent stages. In conjunction with the foregoing, paper expounds the sequence of recalculations for the geometrical dimensions of rotors of the first and subsequent stages of a model pump on the projected pump, conserving in the latter the cavitation qualities of the model pump.

A. S. Gibevskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4041. Kotenev, I. V., Pivoted blade hydroturbine with a self-controlling rotor (in Russian), *Trudi Vses. N.-i. In-ta Gidromashinostr.* no. 19, 149–185, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12718.

During 1952–53 a new type of pivoted blade turbine was examined and studied; this had a new system of control based on pivoting the blades by means of a mechanism acting from the impeller located in the flow downstream from the rotor.

The self-controlling rotor makes it possible to accomplish simply and cheaply at low b.h.p. values the transition from propelling to variable-pitch-action turbines. The replacement of propeller turbines by pivoted blade ones raised energy output by 10–20% and improves the operational conditions. The self-control of the rotors of variable pitch turbines is based on keeping the mean angles of the flow coming off the blades of the rotor constant in all possible combinations of working conditions.

The angle of flow downstream from the rotor in variable pitch turbines is almost invariable in all possible conditions of operation of its working, which makes it feasible to give the impeller a fixed position. Change in direction of the flow behind the rotor is made use of in this turbine to serve as an impulse for control and as a source of energy to bring into play the impeller, and in the role of motive force for the control of power and the speed of the turbine.

The construction of the experimental turbine and the comprehensive investigations were undertaken on a big turbine installation with a rotor of type PL-70 in the All-Soviet Institute of Hydromachine Construction. Investigation of the problem of the influence of the shape of the blades of the impeller on the efficiency of the turbine showed that the best appeared to be profiled blades fixed at some distance from the housing. With this arrangement there is a drop in the efficiency of up to 1.5%. The idle running speed of the self-regulating turbine is lower than that of an ordinary turbine.

When pivoting the blades toward the closure to bring them into motion it is essential to increase the speed by 0.2% when $\varphi = 0°$, by 2% when $\varphi = -10°$ and by 10% when $\varphi = -20°$. The amplitudes of the moments and forces occurring in the mechanism of control were measured. The hydromechanical side of the assembly was also experimented on with variable loads with a self-controlled rotor and with regulators of different systems (the Woodward system with a direct action oil servomotor).

D.-G. A. Butaev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4042. McCarty, J. L., Brooks, G. W., and Magliori, D. J., Wind-tunnel investigation of the effect of angle of attack and flapping-hinge offset on periodic bending moments and flapping of a small rotor, *NASA Memo* 3-3-59L, 44 pp., Mar. 1959.

A two-blade rotor having a diameter of 4 feet and a solidity of 0.037 was tested to study the effect of blade collective pitch angle, rotor angle of attack, flapping-hinge offset, and tip-speed ratio on the double-amplitude blade periodic bending moments and flapping angles during the various stages of transformation between the helicopter and autogiro configuration. The results show that both the bending moments and the flapping angles exhibit a maximum in the transition region and at the higher values of tip-speed ratio. During the transition region, the effect of variations

in blade collective pitch angle and rotor angle of attack depends on the configuration of variables; however, increasing these variables at higher values of μ increases both the flapping angles and the bending moments. From authors' summary

4043. Mayo, A. P., Comparison of measured flapwise structural bending moments on a teetering rotor blade with results calculated from the measured pressure distribution, *NASA Memo* 2-28-59L, Mar. 1959.

The range covered by the comparison includes the hovering condition as well as two forward-flight conditions. The results show that the relatively rapid theoretical method used provides adequate agreement for fatigue-study purposes between the bending moments measured by strain gages and those calculated from pressure measurements. Comparisons are also included between experimental and calculated blade stiffnesses and natural frequencies. From author's summary

4044. Kondrat, K. I., Inductive velocities of the connected eddies of a propeller with nonradial blades (in Russian), *Trudi Leningr. In-ta Aviats. Priborostr.* no. 13, 3–20, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11374.

A computation is made of the velocity induced by a curvilinear carrier eddy, replacing the nonradial blade of the propeller. The formulas obtained are unsuitable for practical calculations, as the velocity of the carrier eddy itself is converted to infinity. The introduction of an eddy of finite thickness does not alter matters, as then the radius of the nucleus of the eddy remains unknown. From the theory of the wing it is known that in similar cases the scheme of the carrier eddy can only be made use of by means of the boundary transition from the carrier eddy surface to the carrier eddy [see, for instance, A. A. Dorodnitsyn, *Prikl. Mat. Mekh.* **8**, no. 1, 1944]. G. I. Maikapar

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4045. Kondrat, K. I., Basic integro-differential equation for a propeller (screw) with nonradial blades (in Russian), *Trudi Leningr. In-ta Aviats. Priborostr.* no. 14, 46–62, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11632.

Taking advantage of previous works [*Trudi Leningr. In-ta Aviats. Priborostr.* no. 10, 1954; no. 13, 1956], author deduces an integro-differential equation for the determination of the circulation. The calculations made show that the influence of the nonradiality on the inductive velocity when computing the circulation can be disregarded. G. I. Maikapar

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4046. Biermann, A. E., and Kohl, R. C., Preliminary study of a piston pump for cryogenic fluids, *NASA Memo* 3-6-59E, 27 pp., Mar. 1959.

Preliminary performance data are presented for a low-speed, five-cylinder piston pump designed to handle boiling hydrogen. The pump is designed to deliver 55 gallons per minute at a discharge pressure of 135 pounds per square inch. The design pump speed is 240 rpm. The report also describes associated cavitation experiments in which liquid nitrogen and water were subcooled as much as 0.6 F by reciprocating a disk in an open vessel containing the test fluids. This method produced a lesser amount of subcooling with liquid hydrogen.

From authors' summary

Flow and Flight Test Techniques and Measurements

(See also Revs. 3911, 3958, 4009, 4234, 4253)

Book—4047. Burton, J., Practice of industrial measurement and control. Vol. I: Pressure, levels, discharges [Pratique de la mesure et du contrôle dans l'industrie. Tome I. Pressions-Niveaux-Débits], Paris, Dunod, 1958, xvi + 400 pp. 4400 F.

Practical manual on hydraulic measurements, mostly for technicians in power plants and heat transfer installations includes: Measurement and observation of pressure and vacuum; manometers of all kinds; gages for liquid level observation and transmission; instruments and methods of discharge measurements: pitometers, anemometers, current meters, weirs, flumes, volumetric devices, orifices and nozzles, venturi tubes; measurement of liquids and gases; water meters, gas meters; calibration of meters. Instruments are of French origin or manufacture. Theoretical part is treated with many elementary details. A set of 21 nomograms eliminates or simplifies computations. Original pitot tube is described incorrectly; it was not difficult to check it in the home town of the inventor.

Book was edited with a great care. Two volumes of the manual will follow: measurement of temperature, humidity and density, calorimetric measurements and others.

S. Kolupaila, USA

Book—4048. Spink, L. K., Principles and practice of flow meter engineering, 8th ed., Foxboro, Mass., The Foxboro Co., 1958, x + 549 pp. $15.

A manual for industrial flow measurements contains characteristics of primary devices (orifices, nozzles, tubes, elbows, pitot tubes, magnetic meter), theory of meters, their mechanisms, indicating, transmitting, totalizing and controlling; installation of liquid flowmeters, viscosity corrections; measurement of liquids in open channels (weirs, Parshall flume, Palmer-Bowlus flume, Kennison nozzle). Several chapters are dedicated to steam-flow and gas-flow measurements. Supplement gives computations in metric units. Many tables and nomograms are given for convenient computations. Tables were carefully prepared, checked on an IBM computor and well edited. Manual is of great value for practical application. S. Kolupaila, USA

4049. Nikolaev, V. V., Influence of viscosity and temperature of the liquid on the degree of error indicated on three-dimensional recorders (in Russian), *Neft. Kh-vo* no. 12, 46–52, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12972.

A method is given for the determination of the error in the readings of a three-dimensional recorder when there are changes of temperature and viscosity in the liquid being measured. The method is based on the determination of the functional relation of the alteration of the slit leakage through the clearances to the revolutions of the recorder and the viscosity of the liquid being measured with the aid of the theory of similarity. As the result of generalization of the experimental data the relations were obtained for the computation of the leakage through the clearances in relation to the viscosity. A method is put forward for the calculation of the experimental characteristic of the recorder on new values of the working temperature and viscosity of the measured liquid.

K. K. Bokov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4050. Novakovic, M., Mercury manometer for high pressures, *Engineering* **186**, 4841, p. 801, Dec. 1958.

4051. Eberlein, A. J., Laboratory pressure measurement requirements for evaluating the air data computer, *Aero. Engng. Rev.* **17,** 4, 53–57, Apr. 1958.

4052. Trathen, W. J., The application of a Magnus effect flow meter as a laboratory teaching device, *GM Engng. J.* **5,** 4, 12–13, Oct.-Nov.-Dec. 1958.

4053. Joyce, A. H., and Ruff, K. E., Dynamic air gaging reduces cycle time in precision measurement, *GM Engng. J.* **5,** 4, 28–32, Oct.-Nov.-Dec. 1958.

4054. van Eepoel, P., Measuring small differences in fluid level (in English), *Houille Blanche* **13,** 5, 576–579, Oct. 1958.

A micromanometer is described which is simple, cannot get out of order, and is unaffected by the liquid leaking or evaporating, requires no special bracket, fitting, adjustment or other manual intervention. It consists of a rigid assembly, which does not give rise to friction between solid bodies and which contains devices for measuring, calibration and the determination of temperatures for corrections.

It has applications in aerodynamics and hydrodynamics. A potentially large amplification factor (> 2000) is associated with a multiple-scale measuring range which is potentially very broad (several centimetres). From author's summary

4055. El-Sisi, S. I., and Shawki, G. S. A., Measurement of oil-film thickness between disks by electrical conductivity, ASME Ann. Meet., New York, N. Y., Nov./Dec. 1958. Pap. 58-A-253, 7 pp.

4056. Beutler, F. J., and Rauch, L. L., Precision measurement of supersonic rocket sled velocity. Part II, *Jet Propulsion* **28,** 12, 809–816, Dec. 1958.

4057. Hall, D. A., Photographic method for hypervelocity measurements, *J. Soc. Mot. Pict. Telev. Engrs.* **68,** 3, 149–151, Mar. 1959.

A slit camera has been designed to permit reliable velocity measurements in low-pressure chambers too small for ballistic pendulums. At two or more viewing ports along a horizontal trajectory, the shadow of the projectile is cast upon a vertical slit. A reduced image of each slit is focused on a film transported in a standard high-speed camera. Timing marks also are put on the film by means of a flashing strobe light. These, together with the measured displacement between projectile images, permit computation of the velocity. The system appears to be the most satisfactory means of attaining accurate hypervelocity measurements. It has been operated with excellent results over a variety of base lengths and gun sizes. From author's summary

4058. Vid, V. E., Method of determining water discharge in open flows by means of photography (in Russian), *Sb. Trudi Novocherkass. Inzh.-melior. In-ta* **5,** 131–137, 1955; Ref. Zh. Mekh. no. 10, 1957, Rev. 11848.

Paper describes a method for determining a water discharge by releasing aerial indicators-integrators from the conduit (a hose) placed along the wetted perimeter of the bed of a river or canal in the given line of direction, and successive photography of the places of their appearance on the water surface. The indicators are released from the openings made in the conduit at different distances, against the current. All the operations in the final result give an accurate photographic record of the line of release of the indicators, and determination of the plane of the curve showing their distribution in nature F. This value is calculated by the formula: $F = F'C$, where F' is the plane of the photographed figure, disposed between the fastened line of direction and the curved outlet of the indicators, while C is the transformation coefficient (the scale of the photograph taken). The determination of the discharge of water is carried out in co-operation with the equation

$$Q = \int_{\omega} u d\omega = \int_0^B db \int_0^H u db$$

which, thanks to the automatic operation of the intergration (functions of velocity distribution by depth $u = f(b)$), is integrated by the indicators, while the integration by width of the flow (B) is fulfilled by integrating into the simplest formula $Q = vF = vCF'$, where v is the speed at which the indicators float up, which, as also in the case of C, is a constant value. The article furnishes comparison data of fairly good quality to check the exactness of the proposed method, which the author collected from his tests in laboratory and natural conditions. But these tests, up to date, have only been made for channels of small width and for rectilinear quiet flows of water. N. P. Zrelov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4059. Lebedev, I. V., Spark method of photographic recording of hydraulic phenomena (in Russian), *Trudi Mosk. Energ. In-ta* no. 19, 154–159, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12958.

A description is given of a method of illuminating an airflow in aerodynamical slit models by introducing into it sparking wood shaving. The recording of the motion of these particles is done with a camera, the lense of which is covered with a rotating disk with two symmetrical slits; this device is able to take photographs of the flight of particles moving with a velocity of 20–30 mps. This is made possible by rotating the disk by means of synchronized motors, moving at 3000 rpm. From photographs obtained in this way it is possible not only to determine the velocity but also the direction of the flow with all the eddy zones, appearing when flowing around an obstacle. However, in a case of this nature, a continuous and massive liberation of glowing particles, with a diameter of 0.25 to 1.0 mm, into the flow is necessary. The method described reduces the time to one-third that required when using the usual methods. N. P. Zrelov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4060. Bomelburg, H. J., A new glow-discharge method for flow visualization in supersonic wind tunnels, *J. Aero/Space Sci.* **25,** 11, 727–728 (Readers' Forum), Nov. 1958.

4061. McFarland, D. R., Investigation of spherical-wave-initiated flow fields around bodies, *NASA Memo* 1-6-59L 48 pp., Feb. 1959.

A bullet-optical technique was used to obtain measurements of the velocity flow fields and vortex movements about various blunt-shaped bodies undergoing a spherical blast wave with a peak positive over-pressure of 4 pounds per square inch. From author's summary

4062. Runckel, J. F., and Swihart, J. M., A hydrogen peroxide hot-jet simulator for wind-tunnel tests of turbojet-exit models, *NASA Memo.* 1-10-59L, 35 pp., Feb. 1959.

A jet-exhaust simulator utilizing catalytic decomposition of hydrogen peroxide is described. The system produces a hot jet which closely simulates the exhaust of turbojet engines and can be installed in wind-tunnel models. Static-test data obtained with convergent nozzles are shown to be in good agreement with ideal values. From authors' summary

4063. Petrick, M., and Swanson, B. S., Radiation attenuation method of measuring density of a two-phase fluid, *Rev. Sci. Instrum.* **29,** 12, 1079–1085, Dec. 1958.

A gamma-ray attenuation technique is presented for measuring density and phase distribution in a two-phase fluid. A comparison is made between a "one-shot" and traverse method. The technique was evaluated on lucite mock-ups of simulated flow patterns encountered in two-phase flow and by a series of tests on an air-water system at atmospheric pressure.

From authors' summary

4064. Fay, C., Cavitation flume of the Department of Hydraulic Machinery (in Hungarian), *Magyar Tud. Akad. Musz. Tud. Oszt. Közl.* **22**, 1–3, 187–194, 1958.

Description of a circulating water tunnel with square working section (200 × 198 mm²)—500 mm long and maximum velocity 18 mps for testing hydrofoils—mounted on vertical pivot across full height of section at adjustable angular setting. Pivot has three-component balance and deep mercury seal which limits maximum pressure in working section to 1.5 atmospheres. Pressure regulation down to vapor pressure is obtained by water of constant pressure flowing into small reservoir ahead of working section and out of its top through syphon with throttle, thus excluding air content variation. Equations give test data correction for friction and obstruction effects, verified by check tests.

Reviewer misses motor size and methods of speed regulation. In contrast with American practice of vaned elbows, long standard elbows are used.

A. Hollander, USA

4065. Aoyagi, K., and Hickey, D. H., Full-scale wind-tunnel investigation of a jet flap in conjunction with a plain flap with blowing boundary-layer control on a 35° sweptback-wing airplane, *NASA Memo* 2-20-59A, 25 pp., Mar. 1959.

The lift data presented were measured at a Reynolds number of 4.5×10^6. The jet flap combined with blowing boundary-layer control at the hinge-line radius produced a higher lift increment than the same amount of blowing at the hinge line. Comparison of estimated and experimental jet flap effectiveness was fair.

From authors' summary

4066. Gainer, T. G., Low-speed wind-tunnel investigation to determine the aerodynamic characteristics of a rectangular wing equipped with a full-span and an inboard half-span jet-augumented flap deflected 55°, *NASA Memo* 1-27-59L, 21 pp., Feb. 1959.

The investigation was made in the Langley 300-mph 7- by 10-foot tunnel on a rectangular wing with an aspect ratio of 8.3 and a thickness-chord ratio of 0.167. The jet-augumented flaps were tested through a momentum-coefficient range up to about 5 and through an angle-of-attack range from −8° to about 24°. Included is a design chart for estimating jet-circulation lift coefficients for wings with partial-span jet-augumented flaps.

From author's summary

4067. Riester, E., Reduction of power and continuous controllability of speed of wind tunnels with an open test section (in German), *Z. Flugwiss.* **6**, 5, 129–142, May 1958.

In order to reduce the power for driving, and also to control the speed of wind tunnels having an open test section for testing jet engines, two types of design are suggested and discussed. One type is designed to run at sonic speeds and consists essentially of a nozzle with a tube of slightly larger diameter pushed over it. Supersonic speeds are obtained with the other type. If the pressure behind the nozzle is too low, a second rhombus for measurement is formed in the free jet, with velocities and dimensions greater than those of the nozzle rhombus. By changing the back-pressure, the velocity of flow can be steadily controlled.

From author's summary

4068. Pound, T. N., A wind tunnel investigation on the effects of surface roughness on the low speed stalling characteristics of a Vampire wing tip, *Aero. Res. Lab., Melbourne, Austral. Note* A-166, 10 pp. + 1 table + 6 figs., Jan. 1958.

The effects of discrete surface roughness on the low-speed stalling characteristics of the outboard section of a full-scale Vampire wing were briefly investigated at a Reynolds number of 2.3×10^6 in the 9-ft × 7-ft wind tunnel.

Roughness configurations were developed to reduce the hysteresis at stall from 3.3° to 0.3°. It was difficult to increase the stalling incidence appreciably without adversely affecting the hysteresis control.

From author's summary

4069. Turner, P. E., Wind tunnel tests on a 6% two-dimensional aerofoil with 25% chord flap, *Aero. Res. Lab., Melbourne, Austral. Note* A-164, 20 pp. + 9 tables + 84 figs., Dec. 1957.

A two-dimensional modified NACA 64-106 airfoil with a 25% chord flap has been tested in a slotted working section at subsonic and transonic speeds, with the flap neutral and at +15° deflection.

With the flap neutral results were obtained over an incidence range of −3° to +5° between $M = 0.3$ and 1.04, including comparative measurements under conditions of natural and fixed transition. The tests at +15° flap deflection covered incidences of −8° to −6° for the Mach number range 0.74 to 0.85, with fixed transition throughout.

Results are presented in the form of pressure distributions and the associated lift and moment coefficients together with wake profiles and the resulting drag coefficients. In addition, hinge moment and flap normal force coefficients are included for the deflected flap.

Tests with the undeflected flap showed that peak values of lift were reached without any violent changes in lift, and that a change in transition from fixed to natural produced higher peak lift values at higher Mach numbers, and caused a considerable increase in the nose-down pitching moment at $M = 0.92$ for small positive lift coefficients.

With the flap deflected downward the drag coefficients were found to be high (up to 0.08) and sensitive to incidence, while the flap normal force coefficient and the negative hinge moment both decreased with Mach number.

From author's summary

4070. Adamson, D., and Boatright, W. B., Investigation of downwash, sidewash, and Mach number distribution behind a rectangular wing at a Mach number of 2.41, *NACA Rep.* 1340, 57 pp., 1957.

An investigation of the nature of the flow field behind a rectangular wing of circular arc cross section has been conducted in the Langley 9-inch supersonic tunnel. Pitot- and static-pressure surveys covering a region of flow behind the wing have been made together with detailed pitot surveys throughout the region of the wake. In addition, the flow direction has been measured by means of a weathercocking vane.

Theoretical calculations have been made to obtain the variation of both downwash and sidewash with angle of attack by using the superposition method of Lagerstrom, Graham, and Grosslight. In addition, the effect of the wing thickness on the sidewash with the wing at 0° angle of attack has been evaluated. Near an angle of attack of 0°, agreement between theory and experiment is good, particularly for the downwash results, except in the plane of the wing, inboard of the tip. In this region the proximity of the shed vortex sheet and the departure of the spanwise distribution of vorticity from theory would account for the disagreement. At higher angles of attack, prediction of downwash depends on a knowledge of the location of the trailing vortex sheet, in order that the downwash may be corrected for its displacement and distortion. The theoretical location of the trailing vortex sheet, based on the

theoretical downwash values integrated downstream from the wing trailing edge, is shown to differ widely from the experimentally determined location.

The rolling-up of the trailing vortex sheet behind the wing tip is evidenced by both the wake surveys and the flow-angle measurements.

From authors' summary

4071. Leavy, L. E., A note on the temperature transients in a supersonic "blow-down" wind tunnel, *J. Roy. Aero. Soc.* **62,** 572, 598–599 (Tech. Notes), Aug. 1958.

4072. Carter, E. C., and Tucker, K. F., Some results of an investigation into the use of air injection in a model of the diffuser for the A.R.A. supersonic tunnel, *Aero. Res. Counc. Lond. Curr. Pap.* 386, 14 pp. + 21 figs., 1958.

4073. Fuller, L., and Reid, J., Experiments on two-dimensional base flow at M = 2.4, *Aero. Res. Counc. Lond. Rep. Mem.* 3064, 16 pp. + 26 figs., 1958.

4074. Crawford, D. H., and McCauley, W. D., Investigation of the laminar aerodynamic heat-transfer characteristics of a hemisphere-cylinder in the Langley 11-inch hypersonic tunnel at a Mach number of 6.8, *NACA Rep.* 1323, 21 pp., 1957.

See AMR **9** (1956), Rev. 4071.

4075. Murphy, J. S., Pressure fluctuations in a blowdown wind tunnel, *J. Aero/Space Sci.* **26,** 1, 61–62 (Readers' Forum), Jan. 1959.

4076. Hussmann, A. W., and Pullman, W. A., Formation of pressure pulses by exhaust blowdown, ASME Ann. Meet., New York, N. Y., Nov./Dec. 1958. Pap. 58-A-145, 19 pp.

4077. Murphy, J. S., Rannie, D., and Timson, G. W., Stagnation temperature control in blowdown wind tunnels, *J. Aero/Space Sci.* **25,** 11, 691–698, Nov. 1958.

A design is presented for limiting the variation in Reynolds number in a blowdown wind tunnel due to changes in stagnation temperature. Experimental results from a 1-by-1-ft supersonic wind tunnel are given.

From authors' summary by C. F. Hansen, USA

4078. Summerfield, M., and McAlevy, R. F., III, The shock tube as a tool for solid propellant ignition research, *Jet Propulsion* **28,** 7, 478–481 (Tech. Notes), July 1958.

4079. Glass, I. I., Shock tubes, Part I. Theory and performance of simple shock tubes, *Univ. Toronto Inst. Aerophys. Rep.* 12, 115 pp. + 19 tables + 179 figs. + 1 plate, May 1958.

Extensive report on flow in constant-area shock tubes. A complete treatment of continuous simple waves and shock waves in a perfect gas is given, including the use of the *p-u* plane and the treatment of wave interaction problems. A number of results for imperfect gases, relaxation and dissociation are given. The one-dimensional inviscid theory is compared to experiments. The wave system due to diaphragm rupture and the effect of boundary-layer growth in the shock tube is discussed in this context.

The report will be very useful for workers in this field, not in the least because many references are given and a large amount of information on ideal and real gas flow is presented in the form of numerous graphs and tables.

L. J. F. Broer, Holland

4080. Hall, J. G., Shock tubes, Part II. Production of strong shock waves; shock tube applications, design, and instrumentation, *Univ. Toronto Inst. Aerophys. Rep.* 12, 117 pp. + 5 tables + 103 figs., May 1958.

This report first treats the production of strong shocks by heating of the driver gas, double diaphragm technique and converging tubes. Ample theoretical and experimental data on the performance of these devices are supplied. Shock-wave attenuation is discussed rather briefly. Various applications of shock tubes are reviewed. Among these are hypersonic shock tunnels, gun tunnels, use of shock tubes for aerophysical research (wave interaction and high-temperature effects) and for combustion and chemical kinetics studies. The last sections are on the construction of shock tubes, inclusive data on the selection of diaphragms and on instrumentation for pressure, density, temperature, wave speed and other measurements.

Report contains a wealth of information and should prove invaluable for all who are engaged on research problems for which shock-tube techniques might provide an answer.

L. J. F. Broer, Holland

4081. Mirels, H., Attenuation in a shock tube due to unsteady-boundary-layer action, *NACA Rep.* 1333, 18 pp. + 1 table, 1957.

See AMR **10** (1957), Rev. 536.

4082. Stephens, Emily W., Free-Flight investigation of a rocket-propelled model to determine the aerodynamic heating on a thin, unswept, untapered, multispar, aluminum-alloy wing at Mach numbers up to 2.22, *NASA Memo* 12-15-58L 38 pp., Jan. 1959.

Aerodynamic heating data have been obtained for a thin, unswept, untapered, multispar, aluminum-alloy wing of a rocket-propelled model at Mach numbers up to 2.22. Temperature measurements made in the skin of the wing and in the internal structures agreed well with calculated values. Measured values of Stanton number were in reasonably good agreement with the theory of Van Driest for flat plates with turbulent boundary layers.

From author's summary

4083. Stepniewski, W. Z., and Dancik, P. J., Flight testing experiments with the tilt-wing aircraft, *Aero/Space Engng.* **18,** 2, 43–50, Feb. 1959.

4084. Hewitt, Helen, and Tripp, R. H., Fundamentals of flight test data processing, *Control Engng.* **5,** 10, 88–92, Oct. 1958.

4085. Rowley, G. C., Automatic data reduction equipment for wind tunnels, *Aero. Res. Counc. Lond. Curr. Pap.* 399, 25 pp. + 24 figs., 1958.

Thermodynamics

(See also Revs. 3712, 3945, 3996, 4040, 4046, 4093, 4094, 4101, 4125)

4086. Scala, S. M., and Baulknight, C. W., Transport and thermodynamic properties in a hypersonic laminar boundary layer. Part 1, Properties of the pure species, *ARS J.* **29,** 1, 39–46, Jan. 1959.

In order to determine the characteristics of hypersonic boundary layers, accurate values of the transport and thermodynamic properties of the gases involved need be known. Calculations have been made of the transport properties (binary diffusion, viscosity and thermal conductivity), and of the thermodynamic properties (specific heat, enthalpy) for the products of dissociated air. Results are presented up to a temperature of 16×10^3 °R. Calculations are based upon the Lennard-Jones 6:12 potential energy

function for the molecular species involved. At the high temperatures, dissociation occurs and atomic species are also present. For simplicity these are treated as elastic spheres.

Results, to reviewer's knowledge, are not available elsewhere and should be valuable in hypersonic flow studies.

R. E. Bolz, USA

4087. Moiseev-Ol'khovskii, I. I., On a plane linear problem of generalized hydrodynamics, *Soviet Phys.-Doklady* **3,** 1, 106-109, Dec. 1958. (Translation of *Dokladf Akad. Nauk, (N. S.) SSSR* **118,** 3, 468-471, Jan.-Feb. 1958 by Amer. Inst. Phys., New York, N. Y.)

By expanding the distribution function in terms of generalized Hermite polynomials, author obtains a solution of Boltzmann's kinetic equation with no limitations on the ratio of relaxation time to the characteristic time interval for the process. Application to the dispersion of small perturbations in a uniform gas yields equations for sound dispersion and "thermal waves" or "second sound". Those for sound dispersion agree closely with the experimental results of M. Greenspan for five monatomic gases [*J. Acoust. Soc. Amer.* **28,** p. 644, 1956].

R. R. Hughes, USA

4088. Savet, P. H., On a stationary temperature separating device used as a measuring and cooling/heating apparatus, ASME-ARS Joint Aviation Conf., Dallas, Tex., March 1958. Pap. 58-AV-28, 12 pp.

Author describes the Ranque-Hilsch tube and attempts to analyze its operation, assuming adiabatic, compressible, inviscid flow. By assuming a particular velocity distribution (so-called solid rotation) and using equations for reversible adiabatic pressure changes, he derives an expression for the cooling and warming theoretically possible to attain in the two portions of the flow which are separated in the tube. He compares his results with some data from Hilsch and concludes that the tube is operating close to its top efficiency. He neglects to explain how a state of solid rotation can be attained with an inviscid fluid or, if viscous stresses transfer momentum, why conduction would not transfer heat as well. The recent work of Eckert et al at the University of Minnesota is not mentioned.

F. I. Badgley, USA

4089. Mortlock, A. J., Error in temperature measurement due to the interdiffusion at the hot junction of a thermocouple, *J. Sci. Instrum.* **35,** 8, 283-284, Aug. 1958.

A simple theoretical treatment is given of the type of aging error which is caused by interdiffusion of the two alloys forming the arms of a thermocouple, and numerical values are inserted which indicate that errors due to this cause can only be of significance at relatively low temperatures and when the tip of the thermocouple is in mechanical contact with the specimen being measured.

M. W. Thring, England

Heat and Mass Transfer

(See also Revs. 3716, 3718, 3785, 3827, 3920, 3928, 4082, 4086, 4089, 4117, 4134, 4148, 4154, 4155, 4227, 4228)

Book—4090. Kreith, F., Principles of heat transfer, Scranton, Pa., International Textbook Co., 1958, xiii + 553. $11.

This textbook is aimed at engineering students at the senior and first-year graduate level. It is definitely for engineers and is not for those who wish any of the theoretical background of heat transfer. There is a wealth of approximate solution, engineering data and the like. The material covered is shown by the chapter headings which include steady one-dimensional conduction, two- and three-dimensional conduction, unsteady conduction, radiation, free convection, forced convection in ducts and over external surfaces, heat transfer with change of phase, heat exchangers, high-speed flow and mass flow transfer. The material is up to date and the reviewer found no particular omissions. There are a number of the typographical errors common to first editions.

This book avoids the analytic approach too much for the reviewer's taste. There is, for example, much less of the theoretical background than in Eckert's book "Introduction to the transfer of heat and mass." However it does fulfill very well its avowed purposes of providing "a convenient reference for practicing engineers interested in fundamental techniques of analyzing heat-transfer problems," and of "presenting a basic introduction to the field of engineering heat transfer."

S. H. Maslen, USA

4091. Newcomb, T. P., The flow of heat in a parallel-faced infinite solid, *Brit. J. Appl. Phys.* **9,** 370-372, Sept. 1958.

Wave-type solution for short times are derived by Laplace transform, when one face is insulated and heat flow through the other falls linearly with time. Close numerical agreement is found with measured temperatures at various distances through a brake lining under constant deceleration.

S. Paterson, Scotland

4092. Wakelin, R. J., Temperature distribution throughout a stack of electrical sheet steel during annealing, *Brit. J. Appl. Phys.* **9,** 9, 353-358, Sept. 1958.

In the hope of improving electrical quality and reducing distortion from thermal stress, temperature distribution is measured through the stack during heating and cooling. Measurements confirm heating period to be adequate, but show large (30%) temperature differences across the sheets during cooling. Standard theory of conductive cooling across the sheets with Newtonian loss from edges gives qualitative agreement, but exaggerates rate of cooling, doubtless through neglect of cover over stack.

S. Paterson, Scotland

4093. De Vries, D. A., and Peck, A. J., On the cylindrical probe of measuring thermal conductivity with special reference to soils. I. Extension of theory and discussion of probe characteristics, *Austral. J. Phys.* **11,** 2, 255-271, June 1958.

Authors present an extension of the theory of cylindrical probes of infinite thermal conductivity for nonstationary thermal conductivity measurements of soils and materials of similar thermal properties to the case of a homogeneous probe of finite conductivity with a line source of heat at its center. An analysis of experimental results made on the basis of this extended theory shows that deviations from the simple theory of a probe of infinite conductivity are negligible if the outer probe diameter and the probe length are of the order of 0.1 cm or less and 10 cm, respectively, and if the thermal conductivity of the probe is large in comparison with that of the observed material, and if the volumetric heat capacities of both are nearly equal. It is shown how an estimate can be made of the influence of the contact resistance between the probe and the observed material on the thermal conductivity of the latter. A negligibly small or accurately known contact resistance makes it possible to find the thermal diffusivity of the investigated material, but no remarkable accuracy is to be expected.

F. Krupka, Czechoslovakia

4094. De Vries, D. A., and Peck, A. J., On the cylindrical probe method of measuring thermal conductivity with special reference to soils. II. Analysis of moisture effects, *Austral. J. Phys.* **11,** 3, 409-423, Sept. 1958.

Effects of uneven moisture distribution caused by temperature gradients and gravity on nonstationary thermal conductivity measurements of unsaturated porous materials by means of cylindrical probes are discussed. An analysis of simplified equations for simultaneous transfer of heat and moisture shows that temperature

gradients produce a decrease of moisture content at the probe surface which is approximately inversedly proportional to the radius of the probe, and increases with increasing time and temperature. For most soils the redistribution of moisture and its effect on the measured temperature rise will be insignificant at average temperatures below about 40C for a probe diameter of 0.1 cm, a heating time of the order of 100 sec, and a temperature rise at the probe surface of less than 1C. The effect of variation of moisture content in the vertical direction due to gravity also is usually negligible. The importance of measuring both the heating and cooling branch of the temperature-time relation in detecting the influence of moisture redistribution is illustrated.

F. Krupka, Czechoslovakia

4095. Goodman, T. R., The heating of slabs with arbitrary heat inputs, AFOSR TN 58-524 (Allied Research Assoc., Inc., Rep.; ASTIA AD 158 337), 17 pp., May 1958.

An approximate analytical method was used to determine the melting rate of a finite slab which was initially at a uniform temperature below the melting point. The heat input at one face was constant and the other face was insulated or kept at its initial temperature. The time history of melting and the temperature distribution in the slab was obtained. W. L. Sibbitt, USA

4096. Goodman, T. R., and Shea, J. J., The melting of finite slabs, AFOSR TN 58-824 (Allied Research Assoc., Inc., Rep.; ASTIA AD 202 908), 40 pp., Aug. 1958.

This is an approximate analytical method applied to the nonlinear problem of a moving boundary (melting) within a solid finite slab. The temperature distribution within the melt and solid as well as the propagation of melting was determined. This method may be used instead of numerical integration using a finite difference procedure.

From authors' summary by W. L. Sibbitt, USA

4097. Seban, R. A., and Johnson, H. A., Heat transfer from a horizontal cylinder rotating in oil, *NASA Memo* 4-22-59W, 31 pp., Apr. 1959.

Measurements of the heat transfer from a horizontal cylinder rotating about its axis have been made with oil as the surrounding fluid. The results embrace a Prandtl number range from about 130 to 660 with Reynolds numbers up to 3×10^4, and show an increasing dependence of free-convection heat transfer on rotation as the Prandtl number is increased by reducing the oil temperature. Some correlation of this effect, which agrees with the prior results for air, has been achieved. At higher rotative speeds the flow becomes turbulent, the free-convection effect vanishes, and the results with oil can be correlated with those for air and with mass-transfer results for even higher Prandtl numbers.

From authors' summary

4098. Poppendiek, H. F., Heat transfer in a liquid metal flowing turbulently through a channel with a step function boundary temperature, *NASA Memo* 2-5-59W, 64 pp., Mar. 1959.

An analytical heat-transfer solution is derived and evaluated for the general case of a turbulently flowing liquid metal which suddenly encounters a step-function boundary temperature in a channel system. Local Nusselt moduli, dimensionless mixed-mean fluid temperatures, and arithmetic-mean Nusselt moduli are given as functions of Reynolds and Prandtl moduli and a dimensionless axial-distance modulus. These solutions are compared with known solutions of more specific systems as well as with a set of experimental liquid-metal heat-transfer data for a thermal entrance region. From author's summary

4099. Cooper, M., and Mayo, E. E., Measurements of local heat transfer and pressure on six 2-inch-diameter blunt bodies at Mach number of 4.95 and at Reynolds numbers per foot up to 81×10^6, *NASA Memo* 1-3-59L, 39 pp., Mar. 1959.

Laminar flow was observed over a hemispherical-nosed body having a surface finish from 10 to 20 microinches at the highest test Reynolds number per foot (for this configuration) of 77.4×10^6. The pressures measured on the hemisphere agreed very well with those of the modified Newtonian theory, whereas the pressures on all other bodies, except on the flatnosed body, were bracketed by those of the modified Newtonian theory both with and without centrifugal forces. Heat-transfer results were compared with those of laminar- and turbulent-flow theories.

From authors' summary

4100. Morrell, G., An empirical method for calculating heat transfer rates in resonating gaseous pipe flow, *Jet Propulsion* **28,** 12, 829-831 (Tech. Notes), Dec. 1958.

4101. Rose, P. H., Probstein, R. F., and Adams, M. C., Turbulent heat transfer through a highly cooled, partially dissociated boundary layer, *J. Aero/Space Sci.* **25,** 12, 751-760, Dec. 1958.

Heat transfer from hot air through a turbulent boundary layer to a cold hemisphere-cylinder was studied theoretically and in shock tubes.

For Prandtl and Lewis numbers of unity the equations of mean motion are essentially the same for a dissociating gas as for a non-dissociating gas if the total enthalpy includes that of dissociation. Furthermore, the incompressible heat transfer result based on external fluid properties applies for the highly cooled turbulent boundary layer with zero pressure gradient. Semiempirical correction factors are presented for Prandtl and Lewis numbers different from unity.

In the shock tube, transition was obtained naturally at a hot-gas Reynolds number of 400,000 to 600,000, and at 100,000 with trip wires. Turbulent heat-transfer at zero pressure gradient agreed with incompressible theory within 15%, though dissociation reached 27%. The departure can be correlated by a correction factor, depending on the Lewis number and degree of dissociation.

C. F. Bonilla, Puerto Rico

4102. Cess, R. D., Approximation of the eigenvalues for heat transfer in turbulent tube flow, *J. Aero/Space Sci.* **25,** 11, 723-724 (Readers' Forum), Nov. 1958.

The asymptotic method based upon the WKB approximation and used by Sellars, Tribus and Klein [AMR **9** (1956), Rev. 1980] to obtain the eigenvalues of the solution for convective heat transfer in laminar tube flow has been applied to the similar case of turbulent flow. Prandtl number of unity has been assumed. The method proved useful for determining the higher eigenvalues.

J. O. Hinze, Holland

4103. Collis, D. C., and Williams, M. J., Molecular and compressibility effects on forced convection of heat from cylinders, *Aero. Res. Lab., Melbourne, Austral. Rep.* A.110, 39 pp. + 11 figs., July 1958.

A review has been made of both theoretical and experimental contributions to this subject. Interest has been restricted to Reynolds numbers less than 1000. It is shown that in slip flow the reciprocal of the heat transfer parameter can be subdivided into contributions from continuum incompressible flow, molecular effects and the effect of compressibility on the flow field.

Topics discussed in some detail are Reynolds number dependence, Mach number effects, Knudsen number correlations and the nonlinear effect of temperature loading.

From authors' summary

4104. Irvine, T. F., Jr., and Eckert, E. R. G., Comparison of experimental information and analytical prediction for laminar entrance pressure drop in ducts with rectangular and triangular cross sections, *J. Appl. Mech.* **25,** 2, 288–290 (Brief Notes), June 1958.

4105. Siegel, R., and Perlmutter, M., Heat transfer in swirling laminar pipe flow, *J. Appl. Mech.* **25,** 2, 295–297, June 1958.

4106. Kleeman, P. W., Survey of thermal problems as affecting the structures of high speed aircraft, *Aero. Res. Lab., Melbourne, Austral., Rep.* SM. 261, 50 pp., June 1958.

This report summarizes the important problems arising from the aerodynamic heating of high-speed aircraft. Problems in the following fields are considered:

1. Aerodynamic heat transfer
2. Heat transfer in the structure
3. Thermal stresses
4. Flutter
5. Creep
6. Fatigue
7. Experimental methods
8. Materials

An extensive bibliography is included.

From author's summary

4107. Petookhov, B. S., and Kirillov, V. V., On heat exchange at turbulent flow of liquid in pipes (in Russian), *Teploenergetika* no. 4, 63–68, 1958.

Paper presents theoretical calculation for heat exchange which takes place in pipes at turbulent flow of liquid possessing constant physical properties. On the basis of experimental data, the effect of alternating viscosity on heat exchange was analyzed. The calculation formula is recommended.

From authors' summary

4108. Collis, D. C., and Williams, M. J., Two-dimensional forced convection from cylinders at low Reynolds numbers, *Aero. Res. Lab., Melbourne, Austral. Rep.* A-105, 35 pp. + 13 figs., Nov. 1957.

Measurements of heat transfer from cylinders placed normal to an airstream have been made in the Reynolds number range 0.01 to 140. The results lead to two-dimensional heat-transfer relations which differ significantly from existing relations for Reynolds numbers below those at which a vortex street is formed. As the Reynolds number tends toward zero the theoretical relation based on the Oseen approximation is approached asymptotically, provided free convection or aspect ratio effects do not intervene. The interaction between free and forced convection is discussed and an approximate criterion for the onset of buoyancy forces is obtained in a particular case.

For cylinders of very small diameter, "temperature jump" reduces the heat-transfer coefficient below the continuum value at the same Reynolds number. The magnitude of this effect is in agreement with the prediction of kinetic theory.

From authors' summary

4109. Vorob'ev, I. N., Problems in the theory of appliances based on the appearance of convection heat emission (in Russian), Sb. Rabot po Avtomatike i Telemekhan., Moscow, Akad. Nauk SSSR, 1956, 94–104; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12830.

For the calculations of systems of automatic control an attempt is made to introduce a generalized criterion for convection heat emission not dependent on the nature of the forces giving rise to the convection.

M. A. Azanova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4110. Acrivos, A., Combined laminar free- and forced-convection heat transfer in external flows, *AIChE J.* **4,** 3, 285–289, Sept. 1958.

Author shows that the parameter Gr/Re^2 is of great importance in problems which involve the calculation of shear stresses and rates of heat transfer in external flows for combined laminar forced and free convection. Natural convection is negligible as $Gr/Re^2 \to 0$, and forced convection has little influence as $Gr/Re^2 \to \infty$. In the special case of heating and cooling of upward flow past a vertical flat plate the application of the parameter is particularly useful.

It was shown that heating stabilizes the boundary layer, whereas cooling hastens the appearance of a separation point.

C. Codegone, Italy

4111. Vulis, L. A., and Trofimenko, A. T., Thermal problems for a laminar stream spreading along a wall (in Russian), *Zh. Tekh. Fiz.* **26,** 12, 2709–2713, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11668.

On the basis of the known solution of the dynamic problem for a plane incompressible laminar stream spreading along a wall [N. I. Akatnov, *Trudi Leningr. Politekhn. In-ta* no. 5, 1953], a solution is found for the thermal problem with different boundary conditions: (1) the boundary conditions for temperature and velocity are similar; (2) there is no heat transfer; (3) the wall temperature is constant. It is shown that the thermal problem on the laminar stream, issuing from a radially slotted diffuser, in the case of automodelling, has an identical solution for each of the cases where the boundary conditions have been investigated.

E. I. Obroskova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4112. Hanratty, T. J., Rosen, E. M., and Kabel, R. L., Effect of heat transfer on flow field at low Reynolds numbers in vertical tubes, *Indust. Engng. Chem.* **50,** 5, 815–820, May 1958.

For the special case of constant flux heat transfer far from the entrance of vertical tubes, authors have theoretically accounted for the effect of natural convection on the equilibrium profiles of velocity and temperature. These profiles are shown to be unique functions of the ratio between the Grashof and Reynolds number, and to be different for the two cases considered, the first case being that of heating in upflow or cooling in downflow, and the second that of cooling in upflow or heating in downflow. Authors claim that the interpretation of their visual experiments, although these were not performed at constant heat flux but at constant temperature, support the aforementioned theoretical results, particularly as regards the observed flow instabilities.

H. Blok, Holland

4113. Mikheev, M. A., Baum, V. A., Voskresenskii, K. D., and Fedunskii, O. S., Heat emission of smelted metals (in Russian), Reactor construction and the theory of reactors; Moscow, Izd-vo Akad. Nauk SSSR, 1955, 139–151; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12810.

Essential information is given about the experimental installations used, the methods of measurement and the procedure employed in carrying out the experiments. Observations were carried out on the heat transmission of tin, lead, bismuth and sodium and mixes of bismuth-lead and sodium-potassium. The velocity of flow varied from 0.1 to 20 m/sec, Reynolds number from 1×10^4 to 6.5×10^5, Prandtl number from 4×10^{-3} to 3.2×10^{-2}, and the specific thermal load from 2×10^6 to 1×10^8 K cal/m^2/hour. On the basis of results obtained for 600 experiments authors propose critical relations for clean and oxidized surfaces. A comparison is made between the experimental data and available theories. Based on the analysis of the various experimental data a new

critical formula is proposed, which is not only claimed to be true for molten metals but for "ordinary" liquids for which the Prandtl number is greater than 0.7. Investigations were also made of the heat emission in large spaces in conditions of natural convection on the plates and pipes for heavy and alkali molten metals and their alloys. As the result of studies of the material data made available by these investigations, and also of the data already available for liquids of low heat conductivity, authors propose a single critical formula for the heat emission in a large space suitable for use in a wide range of variations of Prandtl and Grashof numbers. The data obtained for the hydraulic resistance during the flow of fluid metals indicate that the hydraulic calculations may be carried out by means of the usual formulas in hydraulics. V. N. Krylov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4114. Oman, R. A., and Scheuing, R. A., On slip-flow heat transfer to a flat plate, *J. Aero/Space Sci.* **26,** 2, 126–127 (Readers' Forum), Feb. 1959.

Assuming that continuum flow energy equation in a boundary layer remains valid well into slip region and taking account of the temperature jump in a moving rarefied gas and for influence of large mean free path through appropriate boundary conditions, a solution is found for the temperature gradient in the slip region. Then from Maslen expression [*J. Aero. Sci.* **25,** 6, 400–401, June 1958] an interesting relationship is given for heat transferred by slipping fluid to a flat plate, and behavior confirms results for small values of Knudsen number. V. Ferro, Italy

4115. Strubell, W., On the heating of rocket vehicles entering into the earth's atmosphere (in German), *Astronaut. Acta* **4,** 3, 182–187, 1958.

The problem of determining events which occur as rockets or missiles enter into the earth's atmosphere has been extensively treated several times in the literature. The problem is of increased importance since the carrier rocket of the first Soviet satellite fell into the earth's atmosphere, on or about 6 December 1957, without being vaporized. Prior to this two concepts existed: first, it was thought that a body would entirely vaporize upon entrance into the atmosphere, in a way similar to that of meteors; in accordance with the second conception, such a missile could possibly attain the surface without being totally evaporated. Practical experience seems to have proved this latter view to be true.

This paper attempts to determine, using results of meteor astronomy, which cases would lead to the evaporation of a rocket entering into the earth's atmosphere from space, and in which cases it would not be expected to vaporize.

From author's summary

4116. Hayday, A. A., Mass transfer cooling in a laminar boundary layer in steady two-dimensional stagnation flow, AFOSR TN 58-337 (Heat Transf. Lab., Univ. Minn. Inst. Tech. TN 19; ASTIA AD 154-241), 17 pp. + 19 figs., Apr. 1958.

Analytical investigation of title problem with injection of foreign gas (e.g. hydrogen) as coolant is made. Basic equations are the continuity, momentum, diffusion and energy partial differential equations for a steady, two-dimensional binary mixture boundary layer. For flow near a stagnation point ($U_\infty = ax$) at zero Mach number, with (normal) injection velocity, temperature and mass fraction of coolant all constant along the wall, a suitable ("similarity") transformation yields a set of ordinary differential equations. These are solved here by a modified iteration procedure, for case of hydrogen as coolant gas. Numerical results for both isothermal and non isothermal flow fields for velocity, concentration and temperature profiles, as well as skin-friction and heat transfer, are shown by curves for various injection rates. For sufficiently high injection rates of hydrogen, local velocities in the boundary layer are found to exceed the free-stream velocity. This is explained by the low surface density. It is also found that a high reduction in the heat transferred into the surface can be expected by injection of hydrogen.

M. Morduchow, USA

4117. Espanol, C. E., and Carjuzaa, C. R., Theoretical calculations and experimental verification for a demonstration thermal diffusion column, *Amer. J. Phys.* **27,** 2, 87–89, Feb. 1959.

The present paper exemplifies the theoretical calculations for a thermal diffusion column of the hot filament type, easy to build in college laboratories. The separation of a binary mixture of carbon dioxide and argon has been studied and the separation factor, theoretically calculated, has been checked against the experimental separation factor. The results show an acceptable agreement.

From authors' summary

4118. Leadon, B. M., Scott, C. J., and Anderson, G. E., Mass-transfer cooling of a 20° porous cone at M=5, AFOSR TN 57-461 (Univ. Minnesota, Institute of Technol., Dept. Aero. Engng., Rosemount Aero. Lab. Res. Rep. 143; ASTIA 136 452), 48 pp., July 1957.

Laminar recovery factor, local heat transfer, and surface concentration measurements have been conducted on a 20° porous cone at a nominal Mach number of 5, using both air and helium as the transpired gas. Measured heat-transfer coefficients correlate well with the theories of Low and Baron when presented versus two modified blowing parameters chosen to account for the non-ideal permeability distribution. The laminar conical boundary layer was demonstrated to be quite stable at this Mach number, both with zero injection and with air and helium injection.

From authors' summary

4119. Batchelor, G. K., Diffusion in a fluid in turbulent motion (in Portuguese), *Cienc. y Tecn.* **126,** 631, 3–11, Aug. 1958.

Diffusion is essentially a process of statistical redistribution of material particles of a fluid. Problems of turbulent diffusion are rather complex and many-sided, and there are considerable variations between one particular problem and another. After some general remarks the paper describes some of the particular features of diffusion in turbulent fluid that have already been noticed and are being given some attention. From author's summary

4120. Richmond, J. C., and Stewart, J. E., Spectral emittance of uncoated and ceramic-coated Inconel and type 321 stainless steel, *NASA Memo* 4-9-59W, 30 pp., Apr. 1959.

The normal spectral emittance of Inconel and type 321 steel with different surface treatments was measured at temperatures of 900, 1,200, 1,500, and 1,800 F over a wavelength range of 1.5 to 15 microns. The measurements involved comparison of the radiant energy emitted by the heated specimen with that emitted by a comparison standard at the same temperature. Surface treatments included electropolishing, sandblasting, electropolishing followed by oxidation, sandblasting followed by oxidation, application of NBS coating A-418, and application of NBS ceramic coating N-143.

From authors' summary

4121. Logan, J. G., Jr., Recent advances in determination of radiative properties of gases at high temperatures, *Jet Propulsion* **28,** 12, 795–798, Dec. 1958.

Paper presents a brief status report on the following subjects:

1. Determination of radiative properties of gases.
2. Absorption coefficients of air components.
3. Experimental determination of absorption coefficients.
4. Recent theoretical studies of radiation from high-temperature gases.

5. Radiation phenomena in rocket thrust chambers.
6. Use of shock tube for study of high-temperature radiation phenomena.

Radiative properties of gases (primarily air) in temperature range from 3000 to 10,000 K are discussed. Bibliography of 52 papers is included. W. F. Davis, USA

4122. Simon, A. W., Calculation of the concentration of the solar radiation through the focal spot of a parabolic mirror, *Solar Energy* **2,** 2, 25–29, Apr. 1958.

The distribution of intensity over the solar disk as a function of wavelength is taken into account in computing the radiant energy flux at the focal spot of a paraboloidal mirror.

A. Whillier, South Africa

4123. Simon, A. W., The loss of energy by absorption and reflection in the heliostat and parabolic condenser of a solar furnace, *Solar Energy* **2,** 2, 30–33, Apr. 1958.

Analysis is given of losses in the reflecting system of a solar furnace. A minor error in the paper is in extrapolating glass transmittance characteristics beyond 2.1 microns.

A. Whillier, South Africa

4124. Hottel, H. C., and Cohen, E. S., Radiant heat exchange in a gas-filled enclosure: allowance for nonuniformity of gas temperature, *AIChE J.* **4,** 1, 3–14, Mar. 1958.

A method is presented for predicting the effect of allowance for radiation exchange on the distribution of temperature and heat transfer within a furnace chamber. The system is divided into surface zones and gas zones, the number being dependent on the desired accuracy of the result. Direct-exchange factors are available for gas-gas, gas-surface, and surface-surface zone interchange. From these factors one can determine the net exchange factor for any zone pair, making due allowance for interaction with all other zones. The resultant factors are then fed into a set of energy balances, one on each zone, which by simultaneous solution permit a determination of the space distribution of gas and surface temperatures and the distribution of heat flux over the surfaces. From authors' summary by J. A. Clark, USA

4125. Berman, L. D., Experimental investigation on steam condensation in the media of uncondensible gases (in Russian), *Teploenergetika* no. 6, 43–50, 1957.

Consideration is given to the results of a number of experimental investigations and to the range of possible application of the dependencies for coefficients of heat transfer and mass transfer in steam condensation from the steam-gas mixture. Questionable and erroneous propositions contained in some investigations are pointed out. From author's summary

4126. Atkins, G. T., and Felps, N. O., The heat exchanger—an economic study, ASME-AIChE Joint Heat Transfer Conf., Chicago, Ill., Aug. 1958. Pap. 58-HT-4, 3 pp.

4127. Emmons, W. O., and Sacca, D. B., The design and development of a blood heat exchanger for open heart surgery, *G. M. Engng. J.* **5,** 3, 38–40, July–Aug.–Sept. 1958.

4128. Cima, R. M., and London, A. L., The transient response of a two-fluid counterflow heat exchanger—the gas-turbine regenerator, Trans. ASME 80, 5, 1169–1179, July 1958.

4129. Nesina, L. V., Calculations for heat exchange in water reservoirs (in Russian), *Trudi Gl. Geofiz. Observ.* no. 59 (121), 29–36, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12822.

On the basis of material collected in observations on two water reservoirs (Lake Krasavitsa in the Leningrad region and Tsimlyanskoe) a calculation was carried out for the heat exchange by changes of the heat content of the water. On Lake Krasavitsa the water temperature was taken twice daily (at 8 and at 20 hours) at the surface and up to depths of 15–17 m at every meter of depth. The data for 5 months (from May to September, 1954) were analyzed. Graphs were made of the water temperature from the mid-month data. Tables of heat exchange were prepared (diurnal mean, per day and so forth), from which it is evident that in May there is a strong warming up of the water. In the following months a less intense warming was observable during the day with increasingly intensive cooling during the night. In September the reservoir cools thoroughly. It was found that the advective thermal flow was comparable with the flows into the water obtained by changes in the heat content of the layer of water. The 24-hour variations of temperatures rapidly disappears with the depth of water and at a depth of 2 m is practically nonexistent. But if the wind velocity is above 6 m/sec then the temperatures on the water surface and at a depth of 3 m are the same. A comparison is made of the course taken by the heat exchange and the radiation balance by means of curves. Author comes to the following conclusions, in particular: (1) In calculating heat exchange in water even in the case of shallow reservoirs the heat exchange between water and soil can be disregarded in the first approximation. (2) For the Tsimlyanskii reservoir over a period of 72 hours or more, nearly 12% of heat is consumed from the radiation balance in warming up the water in July. A. S. Sarkisyan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4130. Goodwin, R. D., Design of simple resistance thermometer bridges for wide-range control at low temperatures, *Rev. Sci. Instrum.* **29,** 6, 497–500, June 1958.

4131. Rietdijk, J. A., and Valstar, A., On a thermometer with recovery factor $r > 1$, *Appl. Sci. Res.* (*A*) **7,** 4, 251–255, 1958.

When a bare thermometer is inserted in a high-speed gas flow, it reaches an equilibrium temperature (determined by the balance between energy losses and energy gains) which is between the static and stagnation temperatures of the stream. The difference is described by a recovery factor $r = (T_m - T)/(T_0 - T)$, where T_m is the measured temperature, and T_0 and T are, respectively, the stagnation and static temperatures of the stream. Ideally, the recovery factor should be one, i.e., the measured temperature should correspond to stagnation temperature. Practically, recovery factors of the order of 0.8–0.99 may be obtained, depending upon the precautions taken in designing the probe.

Authors have designed a probe in which recovery factors greater than one have been measured. This is accomplished by heat transfer from part of the stream whose stagnation and static temperatures are nearly equal to another part moving at high velocity and having correspondingly lower static temperature. The two gas streams run in counterflow and in direct contact with each other within the body of a specially designed probe. Values of r of 1.01–1.04 are reported for the Mach number range 0.75–2.5.

E. L. Foster, USA

4132. Persson, P.-O., Hanerus, L., and Kraft, H., Heat flow meter (in Swedish), *Kyltekn. Tidskr.* **17,** 4, 45–48, Aug. 1958.

Combustion

(See also Rev. 4147)

4133. Goodger, E. M., Spontaneous-ignition data of hydrocarbons and aviation fluids, *Coll. Aero. Cranfield Note* 68, 6 pp. + 10 figs., Sept. 1957.

4134. Weeks, D. J., and Saunders, C. A., Some studies of radiating flames in a small gas turbine type combustion chamber, *J. Inst. Fuel* **31,** 209, 247–258, June 1958.

Total radiation and absorption are measured using a pyrometer; spectral radiation and absorption are measured using an infrared spectrometer. Total absorptivities, effective total emissivities, effective temperatures, total emission intensities, and spectral emission intensities are presented for several operating conditions. It is found that radiation is mainly from carbon dioxide and water vapor for the kerosene and the blended fuel, and from carbon particles for the heavy "Mothball" fuel. In the combustor studied, radiation and convection are found to be of comparable magnitude. Therefore, in larger combustors, or in combustors with hotter walls, one would expect radiation to dominate. It is pointed out also that temperature and concentration distributions vary considerably with combustor design, and that, consequently, one would expect radiation and absorption to vary considerably with combustor design. E. L. Knuth, USA

4135. Kenney, W. F., and Albright, L. F., Energy release in flames stabilized by cyclonic flow, *Indust. Engng. Chem.* **51,** 2, 227–228, Feb. 1959.

Cyclonic flow is obtained and studied in 2-in. ducts, 9.5, 19, and 28.5 inches long; combustion efficiencies were determined at propane flows 0.16 to 9.39 mole per hour. Vane diameter was 5 inches or 5.188.

Cyclonic flame was obtained that had an energy release rate of 13,400,000 Btu per hour per cubic foot with a pressure drop of less than 4 inches of mercury. The highest rate of energy release for a flame with complete combustion was 11,800,000 Btu per hour per cubic foot. Stable cyclonic flames were, however, obtained at combustion efficiencies of significantly less than 10% and with very low rates of energy release.

The combustion efficiency and rates of energy release depend primarily on the air-to-fuel ratio, flow rates and degree of cyclonic flow. R. Delbourgo, France

4136. Vasil'ev, A. P., The position of the flame front in a ZhRD combustion chamber (in Russian), Some problems in gas dynamics (MVTU no. 67) Moscow, Oborongiz, 1955, 115–120; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12504.

The particular case is examined of the possibility of oscillation of the flame front in a ZhRD combustion chamber between two relatively stable positions determined by the flow of mixture formed in the pre-ignition zone. In addition to this it is understood that up to the section where the flame front is situated the flow is in the form of a mixture consisting of drops and vapor of unreacted components. Starting from the exponential principle of the change of radius of the drops with time $r = r_0 e^{-kr}$, author obtains an expression for the axial component of the velocity of the gases in the pre-ignition zone of the chamber

$$w_x' = \frac{848T}{pk^F} G\left(\frac{1 - e^{-3k_\Gamma}}{m_\Gamma} + \nu \frac{1 - e^{-3k_0 t}}{m_0}\right)$$

where T and F are the temperature and the plane of the section of the chamber at a distance x from the head, G_Γ is the fuel consumption per second, m_Γ and m_0 are the molecular weights of the fuel and oxidizing agent, r is the time from the moment of delivery of the components into the chamber, K_Γ and K_0 are coefficients characterizing the vaporization rate of the components, $\nu = G_0/G_\Gamma$ represents the relation of the components. In view of the circumstance that the curve of the dependence of the speed of propagation of the flame u on the coefficient of surplus oxidizing agent a has a maximum in the range of values $\alpha = 0.7 - 0.85$, the equality $u = w$ may occur with two values of α, the value of which at different distances from the cylinder head of the engine is determined by the correlation of the rates of vaporization of the mixture components. On this basis author deduces the possibility of the existence of two relatively stable positions for the flame front in different sections of the chamber, which, in his view, must appear to be the source of origin of the oscillations. It should be noted that actually in the ZhRD chamber when working in a steady state the flame front dividing the zone of the initial mixture from the zone of the products of combustion is absent. In consequence of the ejecting action delivered through the liquid atomizer between the dispersion of cones, a partial vacuum is created at the head, and the return currents of gaseous combustion products pass from the zone of spreading combustion to this position and, possessing a high temperature, guarantee the supply of heat essential for the evaporation of the combustible components. Thus, in the initial part of the combustion chamber, the flow has an extremely complicated structure, which cannot be identified with the proposed flow sheet of the working process. A. I. Fedorov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4137. Bozhko, D. F., Investigation of the combustion process in a chamber of the periodic type (in Russian), Some problems of hydrogasdynamics (MVTU no. 67) Moscow, Oborongiz, 1955, 77–114; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12506.

Results are described of the investigation of the influence of the composition of the mixture and the cycle frequency on the process of combustion of a fuel in a chamber into which the fuel components are fed separately. Two independent methods of investigation were adopted: (1) determination of the pressure in the chamber by means of a piezoelectric indicator with a cathode ray tube, and (2) the chromatoscopic separation of the gas with the aid of a special device, followed by analysis of the composition of the gas in a TN apparatus. It is established that an increase in the air/fuel ratio within the limits of 1.18 to 1.45 leads to retardation in the fuel combustion, while raising the cycle frequency within the limits 410–660 cpm leads to acceleration. The highest efficiency in fuel combustion is reached with an air/fuel ratio of 1.35 and the lowest with 1.18. N. S. Vinogradov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4138. Holfelder, O., Experiments on high output tubular and annular combustion chambers with different operating conditions and fuels (in German), *Brennstoff-Warme-Kraft* **10,** 6, 281–288, June 1958.

Tests with various shapes of combustors, arrangement of fuel nozzles, and flame holders have been made to adapt the combustor to the use of heavier fuels, aiming at an improvement of the limits of ignition and blow-off. Further post-war developments of annular and tubular combustors for kerosene, measurements of performance, temperature and velocity distribution and comparison with models using water as a fluid are discussed. The star-shaped probing device may be of special interest for the sampling technique.
W. Gumz, Germany

4139. Rosin, P. O., The mechanism of combustion of pulverized fuel, *J. Inst. Fuel* **31,** 211, 346–355, Aug. 1958.

The mechanics of pulverized fuel (p.f.) combustion is defined as a sequence of different, controllable partial processes. It involves aerodynamic, thermodynamic, physicochemical, and thermophysical aspects. Heating before ignition, devolatilization, ignition, combustion of the volatiles and of the carbonized residue are the various phases which, due to the wide range of particle sizes, overlap considerably. In the aerodynamics of the p.f. flame gravity, centrifugal, buoyancy forces due to the hot gas envelope, and the mechanical thrust exercised by igniting volatiles, act upon the particle. The kinetics of burning the residual coke, differing widely

from volatile matter combustion, is mostly responsible for space requirements. No effort is made to give a mathematical formula, but Godsave's nondimensional rate equation is discussed and the effect of diminishing sizes is shown by calculation. An increase of specific heat release is not advisable, p.f. firing rather should strike an economic balance of grinding cost, capital cost (space requirement) and boiler availability (effect of temperatures on behavior of mineral matter). W. Gumz, Germany

Prime Movers and Propulsion Devices

(See also Revs. 3980, 4062)

4140. Gas-turbine progress report, ASME Ann. Meet., New York, N. Y., Nov.-Dec. 1958. Pap. 58-A-46 (Parts A-M), 141 pp.

Twelve reports plus an introduction afford an excellent review and bibliography of developments for past six years. Introduction charts the maturing of the gas turbine—an uneven process depending on application and size. Materials have improved steadily but not phenomenally; cooling methods have been applied with limited effectiveness, but hope for cooling sufficient to allow use of inexpensive materials in turbines or the use of very high temperatures has not been realized. Fuel picture has changed only slightly—methods of upgrading special residual fuels have been applied, but internal-combustion gas turbines cannot yet use untreated residual fuels nor solid fuels. In aviation, gas turbines, for years ahead in military applications, are coming to fore for commercial service. Variety of small-size gas turbines are available for light-weight portable emergency service, mostly military, but high fuel rate is a deterrent. In automotive field, experimental prototypes have been built based on use of regenerator for fuel economy, with commercial models years away. Locomotives have operated on a limited number of roads. Despite fuel rate higher than diesels, overall economic justification is claimed, yet extent of future application is controversial. Similar uncertainty applies to large ship transport, where free piston and conventional gas turbine have yet to demonstrate superiority over steam. Gas turbines may fit in better than steam for nuclear-fueled systems. Choice of gas and influence on cycle is discussed in review of paper on studies of nuclear systems.

Part of material in reports is related by paper on cycle components, and by one showing compound cycles where gas turbine elements are tied in with reciprocating machinery, as in free-piston systems. Another paper considers tie-in with steam systems.

For the most part, information presented is backed up by experience—testifying to the gas turbine having come of age, with opportunity for considerable growth in future. Reviewer considers this report very helpful in indicating merit of gas turbine relative to other prime movers for particular applications.

D. Aronson, USA

4141. Koizumi, I., Experimental study on exhaust and scavenging process regarding turbocharging of two-cycle diesel engine, *Bull. JSME* **1,** 4, 403-411, Nov. 1958.

As engine outputs increase, designers need to know more about flow processes associated with reciprocating engines. In this way effects of variations in port or value timing an engine performance can be assessed at design stage. Development programs are then shorter and cheaper.

Author's work confirms that good approximation to actual events is obtained by assumption of unidimensional flow. Set-up of test rig includes replacement of turbocharger by nozzle and use of compressed air to obtain release pressure. Wave motion in pipe following discharge is studied by step-by-step process and effect on scavenge air flow is determined. Measured and calculated results show good agreement. Method is suitable for approximate calculations at design stage. Reviewer believes effect of friction should be included in analysis [Wallace & Nassif, *Engineering, Lond.,* **175,** p. 674, 1954], and changes made to bring rig closer to engine conditions.

Further work is planned on influence of piston movement, scavenging process proper, and temperature effects.

W. A. Pullman, England

4142. Wallace, F. J., Theoretical assessment of the performance characteristics of inward radial flow turbines, Instn. Mech. Engrs., Prepr., 1958. 14 pp.

Inward radial flow gas turbines are studied theoretically (1) under design conditions; (2) under part load conditions; (3) by analysis of flow conditions in the rotor passage. Design considerations are discussed and numerical examples given. Isentropic flow is assumed, frictional effects are neglected, and author indicates desirability of experimentation. Parts (2) and (3) are largely original and, in the reviewer's opinion, represent a valuable contribution.

D. G. Huber, Canada

4143. Polikovskii, V. I., and Pichugin, D. F., Development of turbojet engines (in Russian), *Trudî Mosk. Aviats. In-ta* no. 74, 63-74, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12614.

Based on the analysis of available information regarding foreign motors, some statistical data are given on the rate and characteristics of development of turbojet engines. The specific weight of the engines is approaching the figure of 0.2 Kg to 1 Kg of thrust. The relative annual increase in terms of absolute thrust is 10–15%. Specific consumption of fuel decreases each year, nearing the mark of 0.7 Kg to 1 Kg of thrust per hour for engines with axial compressors and 0.9 Kg to 1 Kg of thrust per hour for those with centrifugal compressors.

V. N. Gusev

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4144. Parshchik, S. A., Selection of a pump for a water-jet engine (in Russian), *Sb. Tr. Labor. Gidravl. Mashin. Akad. Nauk USSR* no. 6, 121-134, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12767.

Paper is devoted to a comparative investigation of water-jet engines with axial and lateral water intakes with different systems of working. A comparison is made of the efficiency of screw and water jet engines in dependence on their relative intake (λ). Factors reacting on the k.p.d. (efficiency) of the water jet engine are analyzed, and, as an example, experimental values for the k.p.d. (efficiency) of a water jet engine are put forward for some types of ships. It is shown in conclusion that the rational field of application of water-jet engines is delimited by high values of relative intake or, at given rates of revolution and diameter of the wheel, by high speeds of the ship; the importance is emphasized of coordinating the selection of the type of pump and the contour of the channels in relation to the velocity of movement of the ship.

S. M. Gorlin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4145. Dini, D., An examination of solutions of the underwater ramjet for aerial torpedoes (in Italian), *Aerotecnica* **38,** 3, 145-154, June 1958.

After a summary on the possible use of the underwater ramjet in respect to the conventional propeller torpedo, some practical solutions are presented. A simplified method of computing exhaust velocities, cross-sectional areas, and fuel consumption is

referred to. Moreover, high energy fuels producing high volume rate of gases for a convenient thrust process of the water-gas mixture are reviewed. From author's summary

4146. Rohlik, H. E., Analytical investigation of the significance of turbine-inlet temperature in high-energy rocket turbodrive applications, *NASA Memo* 1-6-59E, 24 pp., Feb. 1959.

Three systems were investigated, hydrogen with a nuclear-reactor heat source, hydrogen-oxygen, and hydrogen-fluorine. Investigation of turbine-inlet temperature required consideration of turbine flow rate and turbine stage number as independent variables; therefore, the results are presented in terms of the ratio of gross weight to payload for ranges of turbine-inlet temperature, turbine flow rate, and turbine stage number.

From author's summary

4147. Messing, W. E., Residual fuel expulsion from a simulated 50,000-pound-thrust liquid-propellant rocket engine having a continuous rocket-type igniter, *NASA Memo* 2-1-59H, 10 pp., Feb. 1959.

Tests were conducted to determine the starting characteristics of a simulated 50,000-pound-thrust rocket engine with a quantity of fuel lying dormant in the main thrust chamber. Ignition was provided by a smaller rocket firing rearward along the center line. Both alcohol-water and anhydrous ammonia were used as the residual fuel. The igniter successfully expelled the maximum amount of residual fuel 3 1/2 gal in 2.9 seconds when the igniter was equipped with a sonic discharge nozzle. When the igniter was equipped with a supersonic exhaust nozzle, a slightly less effective expulsion rate was encountered. From author's summary

4148. Press, S. J., An application of solar radiation to space navigation, *Aero/Space Engng.* **17,** 11, 51-54, Nov. 1958.

Author demonstrates that in a space navigation system using intensity of solar radiation as a measure of distance from the sun the possible error is about 0.05 per cent.

A. Whillier, South Africa

4149. Toralballa, L. V., Durability under varying stress, *Aero/Space Engng.* **17,** 11, 66-69, Nov. 1958.

The durability of some modern devices—e. g., appendages of rocket engines—depends on complex factors which forbid rational analysis; an empirical basis for a rational approach to the problem, however, can be made.

From author's summary

4150. English, R. E., Slone, H. O., Bernatowicz, D. T., Davison, E. H., and Lieblein, S., A 20,000 kilowatt nuclear turboelectric power supply for manned space vehicles, *NASA Memo* 2-20-59E, 65 pp., Mar. 1959.

A conceptual design of a nuclear turboelectric powerplant suitable for manned space vehicles is presented. A thermodynamic cycle using sodium vapor as the working fluid and operating at a turbine-inlet temperature of 2500 R was selected. The total powerplant weight was calculated to be approximately 6 pounds per kilowatt. The radiator necessary for rejecting cycle waste heat contributes approximately 2.1 pounds per kilowatt to the total weight, whereas the reactor and reactor shield contribute approximately 0.24 and 1.2 pounds per kilowatt, respectively.

From authors' summary

Magneto-fluid-dynamics

4151. Kemp, N. H., and Petschek, H. E., Two-dimensional incompressible magneto-hydrodynamic flow across an elliptical solenoid, *J. Fluid Mech.* **4,** 6, 553-584, Nov. 1958.

Problem is formulated under the assumptions of incompressible flow, constant conductivity and negligible (nonmagnetic) body forces. The current is given by the generalized Ohm's law which includes the effect of Hall current and ion slip. The method of small perturbation is employed to obtain the first-order effect of magnetic Reynolds number and the ratio of magnetic force per unit area to dynamic pressure. Effects of angle of attack, fineness ratio of ellipse, Hall current on forces and moments are given in graphs. In some cases, a non-zero ion slip coefficient is also considered. W.-H. Chu, USA

4152. Kolb, A. C., Magnetically confined plasmas, *Phys. Rev.* (2) **112,** 2, 291-296, Oct. 1958.

Present paper describes the results of experiment on the shock pre-heating and the initial stages of compression of plasma, in both "T" and "H"-shaped shock tubes, subject to axial magnetic field induced by a series of single-turn coils.

It is found that the compression in "T"-shaped tube is about 1/3 of the tube radius and that the compressed plasma is remarkably stable. So far as stability is concemed, therefore, the configuration of currents and magnetic fields used in the present experiment is preferable to those encountered in the so-called "pinch effect" where there is high instability against lateral oscillations.

It seems that the present experiment will possibly become one of the starting points for the design of the controlled thermonuclear fusion reactor. S. Tomotika, Japan

4153. Bleviss, Z. O., The effects of combined electric and magnetic fields on hypersonic couette flow, Douglas Aircr. Co. Rep. SM-23314, 47 pp., Oct. 1958.

This valuable contribution extends previous work [*J. Aero/Space Sci.* **25,** p. 601, 1958]. The problem concerns hypersonic ($M = 30$) flow of a thermally ionized gas between parallel planes, one moving, one fixed, bearing rough analogy with the case of a boundary layer between a free stream and a flat plate or cylindrical body. The imposed magnetic field is perpendicular to the planes, and currents circulate perpendicular to the flow and the field. In the previous work the transverse electric field was assumed "shorted out" (as would occur with steady fields and as axisymmetric configuration). This report studies cases ranging from the complete blocking of the total transverse current, so that the fluid polarises, to cases where the current is reversed by electric fields imposed by electrodes to give a propulsive effect. A nonvanishing electric field means that energy is transferred transversely by the currents.

Several cases are solved, some with the fluid properties assumed constant. This simplification gives qualitatively correct results in most cases. Among the conclusions are the facts that no combination of electric and magnetic fields reduces the heating of the fixed wall, although total drag can be increased much more than heating, particularly for zero electric field. The problem is therefore more relevant to re-entry than glide paths. Prospects for propulsion are poor since skin friction is increased at the same time. J. A. Shercliff, England

4154. Gershuni, G. Z., and Zhukhovitskii, E. M., Stationary convective flow of an electrically conducting liquid between parallel plates in a magnetic field, *Soviet Phys.-JETP* **7,** 3, 461-464, Sept. 1958. (Translation of *Zh. Eksp. Teor. Fiz., Akad. Nauk SSSR* **34,** 3, 670-674, Mar. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

An analysis is presented on the induced velocity, temperature and magnetic field distribution between two vertical plates at different temperatures when an extemal magnetic field is applied perpendicular to the plate. The fluid is viscous, electrically and thermally conductive. Neglecting displacement currents in

Maxwell's field equations and viscous dissipation in the energy equation, author solves for the free convective velocity temperature and magnetic field between the two plates in terms of the distance between plates, the Grashof number and the Hartmann number. S. Eskinazi, USA

4155. Gershuni, G. Z., and Zhukhovitskii, E. M., Stability of the stationary convective flow of an electrically conducting liquid between parallel vertical plates in a magnetic field, *Soviet Phys.—JETP* **7,** 3, 465-470, Sept. 1958. (Translation of *Zh. Eksp. Teor. Fiz., Akad. Nauk SSSR* **34,** 3, 670-674, Mar. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.)

Small time-dependent perturbation quantities are introduced in the hydrodynamic, heat-transfer and magnetic field equations. The stability of a free convective flow between two vertical parallel plates at different temperatures with a magnetic field perpendicular to the plates is investigated. The study shows that the stability of the steady flow is increased greatly by the presence of the magnetic field. The stability for the case when the applied magnetic field is parallel to the walls is also discussed. Critical values of Grashof and wave number are presented as a function of the Hartmann number for the transverse and longitudinal magnetic field cases.

S. Eskinazi, USA

4156. Weibel, E. S., Spontaneously growing transverse waves in a plasma due to an anisotropic velocity distribution, *Phys. Rev. Letters* **2,** 3, 83-84, Feb. 1959.

4157. Harris, E. G., Unstable plasma oscillations in a magnetic field, *Phys. Rev. Letters* **2,** 2, 34-36, Jan. 1959.

4158. Kakutani, T., Effect of transverse magnetic field on the flow due to an oscillating flat plate, *J. Phys. Soc. Japan* **13,** 12, 1504-1509, Dec. 1958.

Paper solves the problem of an infinite electrically insulated flat plate oscillating tangentially to its surface in a viscous, electrically conducting incompressible fluid in the presence of an arbitrarily oriented magnetic field. The effect of varying hydrodynamic and magnetic Reynolds numbers and magnetic pressure is discussed, though too briefly for comfort.

L. Trilling, USA

4159. Li, H., Michelson, I., and Rabinowicz, J., Studies in magneto-aerodynamics. Part I. One-dimensional flows. Part II. Stability of laminar boundary layer, AFOSR TN 58-28 (Odin Associates, State College, Pa., O. A. TR 102-1; ASTIA AD 152 206), 11 pp.; 23 pp. + 3 tables + 2 figs., Dec. 1957.

Aeroelasticity

(See also Revs. 4028, 4106)

4160. Shen, S. F., An approximate analysis of nonlinear flutter problems, *J. Aero/Space Sci.* **26,** 1, 25-32, 45, Jan. 1959.

Author first briefly presents fundamentals of well-known method of "harmonic balance" developed by Kryloff and Bogolyubov and then applies method to flutter problems with nonlinear structural stiffness and damping previously treated in the literature.

Author states that one of his aims in writing the paper was to draw attention of practising aeroelasticians to method of harmonic balance. However, it has been pointed out by Magnus [AMR **11** (1958), Rev. 4847] that this method is in fact identical with the more familiar one by Galerkin already widely used by aeroelasticians. A remark in that respect would have been helpful.

H. Parkus, Austria

4161. Johns, D. J., Some panel-flutter studies using piston theory, *J. Aero/Space Sci.* **25,** 11, 679-684, 715, Nov. 1958.

Flutter of rectangular simply supported panels and of elliptically shaped clamped edge panels is considered, and some justification is provided for the use of "static" aerodynamic forces and the neglect of aerodynamic damping. Solution of the flutter equations is made by applying Galerkin's method to a Rayleigh-type analysis using assumed modes of deformation.

From author's summary by H. M. Voss, USA

4162. Woolston, D. S., Clevenson, S. A., and Leadbetter, S. A., Analytical and experimental investigation of aerodynamic forces and moments on low-aspect-ratio wings undergoing flapping oscillations, *NACA TN* 4302, 15 pp. + 1 table + 5 figs., Aug. 1958.

Results obtained by use of the kernel function method for the aerodynamic forces and moments on some low-aspect-ratio wings undergoing flapping oscillations at $M = 0$ are presented. Four wings are considered, namely one rectangular wing of $A = 2$ and three $A = 3$ tapered wings of quarter chord sweep ranging from 0° to 45°. For the rectangular wing a comparison is made with wind-tunnel measurements. Good agreement is obtained for the vector magnitudes but less good for the phase angles which differ up to about 20°. No explanation is given for this discrepancy.

Reviewer considers the report a useful contribution to the sparse literature concerning aerodynamic forces on deforming wings. The reader misses some information on the estimated accuracy of the calculated results, or at least on the number of functions that the aerodynamic loading is approximated by.

M. T. Landahl, Sweden

4163. Smirnov, L. P., and Pavlikhina, M. A., Vortex street in case of flow past vibrating cylinders (in Roumanian), *Studii Si Cercetări Mecan. Appl.* **9,** 2, 307-318, 1958.

An experimental study on the flow structure past a vibrating cylinder subjected to forced vibrations which are perpendicular to the flow direction. The experimental characteristics are: cylinder diameters $D_1 = 41$ mm and $D_2 = 66.5$ mm; vibration amplitude $a = 15$ mm; water velocities in the hydrodynamic channel $v_1 = 12$ cm/s and $v_2 = 16$ cm/s. Authors obtain diagrams for the vortices formed behind the cylinders, for the cylinder vibrating frequency as well as diagrams for the dependence of the vortex Strouhal number $Sh_1 = n_1 D/v$ on the cylinder Strouhal number $Sh_2 = n_2 D/v$. (The Strouhal number is defined as $Sh = nD/v$, where n stands for the vortex vibration frequency, D is the cylinder diameter and v is the flow velocity).

Paper includes considerations according to which the data obtained may prove of importance for establishing the variation regions of the flow velocity, within which intense cylinder self-vibrations occur. D. Gh. Ionescu, Roumania

Aeronautics

(See Rev. 3913)

Astronautics

(See also Revs. 3773, 3989, 4023, 4056, 4115, 4146, 4150)

Book—4164. Konobeevskii, S. T., and Shpol'skii, A. V., (edited by), The Russian literature of satellites, Part I (translated from Russian), New York, International Physical Index, Inc., 181 pp., 1958. $10.

Selection of six papers pertaining to launching earth satellites was prompted by increased readers' interest, International Geo-

physical Year, and the 100th anniversary of birth of K. E. Tsoikovskii, pioneer in indicating in scientific way the possibilities of penetration beyond the Earth's boundaries. According to Russian editors these papers, while they do not encompass all aspects of the subject, illustrate problems involving motion of satellites and scientific research that can be accomplished. These papers were assembled in 63rd volume of "Progress in Physical Sciences" by Academy of Sciences, USSR. Reviewer concurs with editors of International Physical Index, Inc., who felt that quality of papers is worthy of enormous effort of producing this translation. Description of papers follows:

1. "Certain variational problems associated with launching of artificial earth satellite" by D. E. Okhotzimskii and T. M. Eneev.

Authors investigate placing satellite in orbit by one or several stages of rocket accelerators. Using simplified assumptions by simultaneously selecting mode of fuel consumption and program of thrust direction, authors studied relationship between thrust direction and minimum fuel. Multistage accelerator with variable number of stages for fixed fuel consumption is also considered. Results are generalized to apply for motion in central gravitational field taking in account earth's rotation.

2. "Determining lifetime of artificial earth satellite and investigating secular perturbations of its orbit" by D. E. Okhotsimskii, T. M. Eneev, and G. P. Taratynova.

Authors point out accumulation of errors from use of approximate methods for estimating lifetime of satellite in elliptical orbit and develop more rapid and reliable method for general case. They established existence of universal relationship among basic parameters of osculating ellipse which depend solely on density distribution law of air with respect to altitude. Complete solution was reduced to plotting series of integral curves, based on single independent parameter for first-order equation. Graphs and tables are developed. Authors offer law of time variation of orbital parameters for any satellite parameters for wide range of initial orbital parameters.

3. "Motion of artificial earth satellite in non-central gravitational field of earth when atmospheric resistance is present" by G. P. Taratynova.

Author develops and analyzes method determining orbit of satellite taking into account basic perturbating forces which represent atmospheric resistance when atmosphere moves with the earth. Author analyzes effect of deviation of gravitational field from central field. Perturbing effects of sun and moon were considered negligible for this case.

4. "Effect of geophysical factors on motion of satellite" by I. M. Iatsunskii.

Author evaluates presently attainable accuracy when effects of geophysical factors are considered. Preliminary ideas are stated for refinement of force field based on results obtained from measurements of orbit. From analysis of low altitude orbit author observes large errors in predicting orbit using available theory of errors. Author states that for measurements over a long period of time considerable refinement of data is possible on atmospheric density at altitudes of 150 to 300 km. It is observed that greater territory and time of orbital measurements produce greater reliability of results.

5. "Certain problems of moon flight dynamics" by V. A. Egorov.

Author's investigations are contained in seven extensive sections, supplemented by introduction and remarks. This review is limited to only a few typical finds. Author's method resulted in selection of trajectories of appropriate shapes and properties for each specific type of lunar flight. The initial conditions and the required accuracy can be determined after proper selection is made. Perturbations produced by sun and other secondary factors are taken into consideration. Solutions are practical even for cases when correction of trajectory during the passive states by auxiliary motors are required. Author's method appears to be applicable to investigations of interplanetary trajectories. Author's approximate method can be generalized for spatial motion. Characteristic phases making up trajectory remain unchanged though located in different plane. Conversion formulas change at points of intersection between trajectories and boundary of sphere of action. Laws governing each phase are maintained.

6. "Use of artificial satellites for verifying general relativity theory" by V. L. Ginzburg.

Author provides discussion on verification of few effects derived from Theory of Relativity, such as effect of perihelion rotation, bending of light beams close to sun, gravitational shift of spectral lines, etc. Author provides formula for frequency shift in terms of gravitational potentials and observes that artificial satellites can be very instrumental for detecting relativistic effects.

V. A. Valey, USA

4165. Gedeon, G.S., Orbital mechanics of satellites, Proc. Amer. Astronautical Soc., Western Regional Meeting, Palo Alto, Calif., Aug. 1958. 23 pp. + 20 figs.

Although the classical problems of determining an elliptical orbit from given initial value conditions and vice-versa are the main topics of this paper, it makes a valuable contribution by displaying the relations required for solutions as charts suited for graphical calculation.

The interception problem is discussed briefly. Perturbing effects (caused by earth's oblateness, drag, etc.) are not included.

P. G. Kirmser, USA

4166. Newton, R. R., Motion of a satellite around an unsymmetrical central body, *J. Appl. Phys.* **30,** 1, 115-117, Jan. 1958.

The equations of motion of a particle moving in a plane under the action of two fixed centers of gravitation were first integrated by Euler, and the motion of the particle can be described in terms of elliptic integrals. Author analyzes the elliptic integrals under the assumption that one of the fixed centers of gravitation has a small mass compared to the mass of the second fixed center of gravitation. An explicit formula for the number of revolutions which the satellite will suffer before impact with a sphere surrounding the larger mass is obtained by an ingenious analysis. The motion of a satellite of the moon is discussed and it is shown that, if the satellite is initially 22 miles above the moon's surface, impact with the moon will occur on the first revolution. However, there are various ways in which one can replace the gravitational field of the moon by two fixed centers of gravitation which will yield the proper "bulge" of the moon toward the earth, such that only a precession of the lines of nodes and apses will occur.

H. Lass, USA

4167. Vertregt, M., Derivation of the orbit from the vector of the orbital velocity (in German), *Astronaut. Acta* **4,** 2, 135-137, 1958.

Expressions are derived for the elements of an elliptical orbit in a central gravitational field, in function of the velocity vector at a given radial distance. The derivations constitute a simplification of an unwieldy development published earlier [Schütte, at IV I. A. F. Congress, 1953], but are not intended to yield new results.

It apparently must have escaped the author's attention that similar simplifications were presented before by Krause in *Weltraumfahrt* **5,** no. 2, Apr. 1954.

H. F. Michielsen, USA

4168. Leitmann, G., Optimum thrust direction for maximum range, *J. Brit. Interplanetary Soc.* **16,** 9, 503-507, Sept.-Oct. 1958.

Note derives the conditions necessary for the existence of an optimum thrust direction for maximum range. The conditions are

limited to flight of a specified rocket configuration *in vacuo* over a flat, non-rotating earth.

H. P. Liepman, USA

4169. Berger, W. J., and Ricupito, J. R., Visibility of orbital points, *Jet Propulsion* **28,** 12, 825-827 (Tech. Notes), Dec. 1958.

Conditions are found under which a satellite is visible from an earth station. It amounts to some simple transformations of coordinates, which it probably is easier for the reader to develop ab initio than from the note, particularly since the expressions purported to be useful are not worked out explicitly.

R. E. Roberson, USA

Ballistics, Explosions

(See also Rev. 3979)

4170. Roberson, R. E., Oblateness correction to impact points of ballistic rockets, *J. Franklin Inst.* **266,** 6, 465-481, Dec. 1958.

This paper develops a method for investigating the effect of the oblateness of the Earth on the impact point of a ballistic missile. Suitable descriptive variables are chosen, so that the oblateness perturbations can be obtained by quadrature. Explicit results are obtained, relative to the changes in range angle, lateral displacement, and time of flight. The analysis is concerned with first-order effects in an oblateness parameter and with ranges less than half-way around the Earth. An illustrative numerical example is supplied in connection with a long-range trajectory.

A. Miele, USA

4171. Korobeinikov, V. P., and Riazanov, E. V., Solutions of singular cases of point-explosions in a gas (in Russian), *Prikl. Mat. Mekh.* **23,** 2, 384-387, 1959.

Spreading of plane, cylindrical, and spherical blast waves into a medium at rest with initial density distributions $\rho_1 = Ar^{-\omega}$ (with A and ω unspecified constants) is examined. For special combinations of ω and the adiabatic exponent γ the general solutions of Sedov ["Similarity and dimensional analysis in mechanics," 4th ed., Moscow 1957] cannot be carried out because of singularities in the governing equations. The solutions are furnished for two types of singularities. It is shown that the physical solutions are actually continuous in γ for all types of singularities.

M. V. Morkovin, USA

4172. Kochina, N. N., and Mel'nikova, N. S., Strong point-blasts in a compressible medium, *J. Appl. Math. Mech.* (*Prikl. Math. Mekh.*), **22,** 1, 1-19, 1958. (Reprint order no. PMM 1, Pergamon Press, 122 E. 55th St., New York 22, N. Y.

Following the work of L. I. Sedov, the authors present some particular similarity solutions of the problem of strong point blasts in compressible media. Three different forms of the equation of state relating pressure, entropy and density are used, and the case of spherical symmetry is investigated in some detail.

A. K. Oppenheim, USA

Acoustics

(See also Revs. 3848, 3856, 4087, 4170)

4173. Barkhatov, A. N., and Shmelev, I. I., Attenuation of a sound beam upon traversing a layer of discontinuity in the velocity of sound, *Soviet Phys.-Acoustics* **4,** 2, 125-127, Dec. 1958. (Translation of *Akust. Zh.* **4,** 2, 125-127, Apr.-June 1958 by Amer. Inst. Phys., New York, N. Y.)

A brief note on measurements of the attenuation of sound as it traverses a layer of discontinuity in sound velocity. Layer is generated by diffusion of salt solution into a water layer. Measurements using a hydrophone of sound pressure from a beam of 500 kc/s pulsed ultrasonics agree to some extent with the geometrical spread of the beam calculated from a simple refraction. Conditions were arranged so that no appreciable reflection at the discontinuity occurred.

K. W. Hillier, England

4174. Skudrzyk, E. J., Sound radiation of a system with a finite or an infinite number of resonances, *J. Acoust. Soc. Amer.* **30,** 12, 1152-1158, Dec. 1958.

The radiation field of a complex radiator is assessed by using two elementary models. One is the pulsating sphere, the other is the vibrating plate possessing nodal lines. The behavior of the complex radiator may be imagined to be built up from a sphere-type radiator accounting for an essentially source field and of the radiation of a finite vibrating plate.

Typical phenomena, such as the difference between near-field and far-field, acoustic short circuit, apparent mass and radiation impedance, are quite well represented with this simplified treatment.

L. S. G. Kovasznay, USA

4175. Khaikovich, I. M., and Khalfin, L. A., The effective dynamic parameters for sound propagation in inhomogeneous media, *Soviet Phys.-Acoustics* **4,** 3, 280-286, Dec. 1958. (Translation of *Akust. Zh.* **4,** 3, 275-281, July-Sept. 1958 by Amer. Inst. Phys., New York, N. Y.)

Paper investigates the effect of inhomogeneities, distributed in a homogeneous medium in the form of a rectangular lattice, on the dynamic parameters which characterize the propagation of sound waves. Equations are obtained for calculating the "effective" parameters of the nonuniform medium. It is shown that the presence of inhomogeneities leads to dispersion and adsorption.

From authors' summary

4176. Naugolnykh, K. A., On the absorption of sound waves of finite amplitude (a survey), *Soviet Phys.-Acoustics* **4,** 2, 115-124, Dec. 1958. (Translation of *Akust. Zh.* **4,** 2, 115-124, Apr.-June 1958 by Amer. Inst. Phys., New York, N. Y.)

A systematic account is given of theoretical work on increased absorption of finite amplitude waves in media with shear- and volume viscosity. The limitations of the theory are investigated and results compared with experimental data. Both theoretical and experimental results indicate a marked increase in absorption at finite amplitudes (e.g. doubling absorption in water at 100 Kc and 0.01-atmos pressure amplitude).

F. E. Borgnis, Germany

4177. Koyasu, M., On the relation between the reverberant sound absorption coefficient and the normal incidence absorption coefficient of fibrous materials, *J. Acoust. Soc. Amer.* **30,** 12, 1163-1164, Dec. 1958.

4178. Ivanovskii, A. I., The connection of acoustic streaming with absorption, *Soviet Phys.—Acoustics* **4,** 2, 142-152, Dec. 1958. (Translation of *Akust. Zh.* **4,** 2, 143-152, Apr.-June 1958 by Amer. Inst. Phys., New York, N. Y.)

This is an improved treatment of acoustic wind problems first attacked by Eckart [*Phys. Rev.* **73,** p. 68, 1948]. Relations from relaxation hydrodynamics and from Boltzmann elastic after-effect theory are introduced into the Navier-Stokes equation. The streaming effect is shown to depend on the presence of sound absorption. Frequency dependence of stream velocity is given in terms of behavior of absorption coefficient. Equations indicate how to calculate elastic after-effect from experimentally determined elastic and viscous parameters. Streaming cannot exceed velocity of sound. Paper is completely analytical.

V. Salmon, USA

4179. Barkhatov, A. N., The sound field in a medium with a homogeneous surface layer, *Soviet Phys.—Acoustics* **4,** 1, 11–16, Oct. 1958. (Translation of *Akust. Zh.* **4,** 1, 13–18, Jan./Mar. 1958 by Amer. Inst. Phys., Inc., New York, N. Y.).

An experimental study is made of the sound field in a space consisting of the surface layer and an underlying medium with a constant negative sound velocity gradient; the analysis is performed for various positions of the radiator. A comparison is made with geometric and wave theories.

From author's summary

4180. Heckl, M., Experimental investigation of sound insulation of cylinders (in German), *Acustica* **9,** 1, 259–265, 1958.

There are two characteristic frequencies related to the sound insulation of hollow cylinders. One of them is the radial-resonance frequency. For frequencies higher than the radial-resonance frequency the sound insulation of a hollow cylinder corresponds to that of a plane plate. The second characteristic frequency is given when the wavelength in air is equal to the diameter of the tube. For lower frequencies the sound insulation depends very much on the directivity of the exciting sound source and the length of the cylinder.

Between these two frequencies well-marked transmission bands are observed when exciting with noise of small band width. When exciting with noise of octave band width the insulation is found to be nearly independent of frequency.

The sound insulation is different depending on the position of the sound source inside or outside the tube.

From author's summary

4181. Baron, M. L., Response of nonlinearly supported boundaries to shock waves, *J. Appl. Mech.* **24,** 4, 501–505, Dec. 1957. See AMR **11** (1958), Rev. 1256.

Book—4182. Industrial noise manual, Detroit, American Industrial Hygiene Association, 1958, viii + 180 pp. + index. $7.50.

This reviewer finds the subject manual is by far the best reference source which is currently available in the literature. There is a sound background of theory expressed in terms which quickly convey meaning. The section on the characteristics of microphones is extremely valuable. The practical application of sound measurement and attenuation is extremely well handled. The compilers of the data of this manual are to be complimented.

In the event there is another publication of this manual this reviewer would like to see more comprehensive treatment of the use of the oscilloscope in conjunction with suitable R/C discriminatory networks in the voltage amplifier which transduces sound energy to electrical energy. This arrangement would be particularly valuable in studies of frequencies above the normally audible range.

Reviewer also feels that, in the case of outdoor sound measurement over appreciable distance, factors for wind velocity would be very useful. Also factors for altitude correction might be useful.

R. D. Reed, USA

4183. Miller, L. N., Beranek, L. L., and Kryter, K. D., Airports and jet noise, *Noise Control* **5,** 1, 24–31, Jan. 1959.

4184. Gibbs, R. M., and Howell, H. H., Noise characteristics for the Boeing 707, *Noise Control* **5,** 1, 13–17, 80, Jan. 1959.

4185. MacLean, W. R., On the acoustics of cocktail parties, *J. Acoust. Soc. Amer.* **31,** 1, 79–80, Jan. 1959.

Parties are classified as loud or quiet, and the distinction is shown to depend often upon a critical acoustic relationship rather than upon the guests themselves. An explicit formula is found for the maximum number N of well-mannered guests compatible with the quiet party. When this number is exceeded, the party will become a loud one within a calculable time T.

From author's summary

4186. Skudrzyk, E. J., Theory of noise and vibration insulation of a system with many resonances, *J. Acoust. Soc. Amer.* **31,** 1, 68–74, Jan. 1959.

This paper, the second part of a sound insulation study, summarizes the theoretical results of two previous papers [title source **30,** pp. 1140–1158, Dec. 1958]. Analytical relationships are presented for motion and sound radiation of a system with many natural frequencies. Classical results based on analysis of a simple system with one resonance are compared with many-degrees-of-freedom case. Detailed analysis is presented for a fan or motor spring-mounted in a housing or on a shell or plate. Quality of insulation is shown to be a function of the ratio of the square of the lowest fully excited resonant frequency to that of the frequency of the exciting force at lower frequencies. Any increase in the fundamental natural frequency of the housing tends to improve vibration insulation. Noise radiation to greater distances can be reduced by increasing the mass of the radiating shell. Damping is an effective noise reducer at lower frequencies.

Reviewer believes results should be of interest to acoustical and vibration engineers. R. B. Grant, USA

4187. Bouwman, H. B., Spectra and abatement of noises of several types of fans, especially centrifugal fans (in Dutch), *Ingenieur* **70,** 38, 129–138, Sept. 1958.

After a survey about noise, hearing and masking of tones and other noises appearing in airconditioning practice, the measuring instruments are described in detail. The method of measuring fan noise is described. Noise spectra are given as a function of fan type, working point and rotating speed.

It is shown that, with reasonable results, forecasting the noise of a fan spectrum is possible if the spectrum of the prototype at the same working point and about the same pressure is known.

Noise levels are compared of different fans giving the same volume and pressure. A systematic survey is given of the methods to abate airborne fan noise in airconditioning systems.

From author's summary

4188. Etkin, B., and Ribner, H. S., Canadian research in aerodynamic noise, Univ. Toronto, Inst. Aerophys. Rep. 13, 17 pp. + 44 figs., July 1958.

4189. Sanders, G. J., Identification and diagnosis of noise problems with reference to product noise quieting, *Noise Control* **4,** 2, 15–21, 72–73, Mar. 1958.

4190. Kraichnan, R. H., Noise transmission from boundary layer pressure fluctuations, *WADC TN* 56-263 (PB 121 894; ASTIA AD 110 523), 55 pp., Mar. 1956.

Theoretical study is made of noise power and spectra radiated by vibration of thin flat panels under action of turbulent boundary-layer pressure fluctuations. Exciting pressure distribution is represented as an almost frozen pattern that is swept over successive panels by mean flow: both "sharp" and distributed convection speeds are treated. An idealized pressure space spectrum is postulated proportional to wave number κ squared with upper limit cutoff, based on previous studies by author on dynamics of turbulent shear flow [AMR **9** (1956), Revs. 4003, 4104]; frequency spectrum follows from quasi-rigid convection hypothesis. Terms in κ_1^2, κ_3^2 are interpreted as arising, respectively, from longitudinal and transverse quadrupoles; noise excited by the two kinds of spectrum terms is treated separately.

Analysis is not fully understood by this reviewer, and what follows must be regarded as an interpretation rather than a statement

of fact. Modes of surface vibration are defined and admittance concept is used, apparently implying a matched pressure distribution mode in each case. Boundary-layer pressure pattern is in effect reexpressed as a distribution of such pressure modes by use of Fourier transform technique: distribution function gives mean-square-pressure amplitude in each mode at frequency ω per unit bandwidth. Multiplication by mean-square-admittance yields mean-square-panel-vibration velocity amplitude at frequency ω in each mode.

Radiated sound field is expressed in terms of plane sinusoidal waves by Fourier integral. Panel motion is expressed in effect in terms of sinusoidal waves on an infinite surface by taking Fourier transforms of the normal modes (this leads to spectral density of surface velocity). Sound field waves are matched to surface waves (in terms of an impedance concept) to yield finally radiated sound power as function of frequency. In effecting this it is assumed the different modes, and the different panels, are uncorrelated in their motion.

At moderate subsonic Mach numbers and typical parameter values, total transmitted power varies approximately as fifth power of Mach number, for sufficiently thin boundary layers. At lower Mach numbers, dependence may be flatter and, near certain transonic velocities, should be steeper. The dominant transmitted frequencies shift up with Mach number, varying, under certain conditions, as Mach number squared. Plate parameters which importantly influence sound transmission include mass/unit area, size of independent plate sections, stiffness, and damping factors for the various vibrational modes. For sufficiently thin boundary layers, transmitted spectrum shape is essentially independent of boundary-layer thickness, but total transmitted power varies approximately as fourth power of the thickness. For thicker boundary layers, dependence is flatter and Mach number dependence is also flattened. Several possible procedures for reducing the noise transmission are mentioned briefly. H. S. Ribner, Canada

4191. Maglieri, D. J., and Carlson, H. W., The shock-wave noise problem of supersonic aircraft in steady flight, *NASA Memo* 3-4-59L, 15 pp., Apr. 1959.

An insight into the nature of the shock-wave noise problem, the significant variables involved, and the manner in which airplane operation may be affected are presented. Flight-test data are also given, along with a comparison with the available theory. An attempt is also made to correlate the subjective reactions of observers and some physical phenomena associated with the pressure amplitudes during full-scale flight.

From authors' summary

4192. Kuchmin, O. I., On an acoustical method of gas analysis, *Soviet Phys.-Acoustics* **4,** 3, 268–271, Dec. 1958. (Translation of *Akust. Zh.* **4,** 3, 263–266, July–Sept. 1958 by Amer. Inst. Phys., New York, N. Y.)

Paper describes an acoustical phasometric method of gas analysis based on a comparison of the phases of a sound generator and receiver placed in a tube with the gas mixture to be analyzed. In the example of an oxygen-nitrogen system the possible industrial application of this method is demonstrated so as to insure rapidity and sufficient accuracy of measurement.

From author's summary

4193. Skudrzyk, E. J., Vibrations of a system with a finite or an infinite number of resonances, *J. Acoust. Soc. Amer.* **30,** 12, 1140–1152, Dec. 1958.

Author considers harmonic forced vibrations of a mechanical system and derives the expression of impedance $Z(A)$ in a point of the system, $Z(A)$ is the ratio between the total driving force f_0 and the velocity in A. $Z(A)$ is expressed by the eigenfunctions of the free vibration of the dissipationless system; dissipation phenomena are taken into account by introducing complex elastic constant. $Z(A)$ is given by a series, but for higher frequencies it is possible to replace the series by an integral, and author evaluates this integral. Author introduces also the effective impedance Z_{eff}, i.e. ratio between f_0 and mean square velocities, and exposes some properties of $Z(A)$ and Z_{eff}. In the appendix, $Z(A)$ is evaluated for a rod, a rectangular plate, and a circular plate.

D. Graffi, Italy

4194. Keck, G., Ultrasonic observations on surface of liquids (in German), *Acustica* **7,** 5, 310–312, 1957.

When an ultrasonic generator is lifted out of a liquid surface, it draws a column of liquid with it. Observations on such liquid columns are reported. From author's summary

4195. Burov, V. A., and Krasil'nikov, V. A., Direct observation of the deformation of intense ultrasonic waves in liquids, *Soviet Phys.-Doklady* **3,** 1, 173–176, Dec. 1958. (Translation of *Doklady Akad. Nauk SSSR (N. S.)* **118,** 5, 920–923, Jan.–Feb. 1958 by Amer. Inst. Phys., New York, N. Y.)

Micromeritics

(See also Revs. 3961, 3967)

4196. Akai, K., The dilatancy effect during shear of sands (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 58, 76–81, Sept. 1958.

Author points out that the dilatancy effect is one of the most important factors on the strength character of soil, especially in the shearing deformation of sands, and he defines the "dilatancy index," which is the increment of volume dilatation caused by the change of unit shearing strain, in order to express the dilatancy effect quantitatively. Throughout the triaxial compression tests, some behaviors of sands during shear, including the determination of the critical void ratios, are explained in the light of this new index. From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineering

4197. Ohara, S., Determination of elastic constants of sands on the variable confining pressures (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 58, 82–85, Sept. 1958.

Dynamic moduli of elasticity of sand are indispensible for the calculation of the seismic earth pressure onthe quay wall. Author has measured them by the resonance method, changing the confining pressure of sand, and found that they increase in simple proportion to the confining pressure. Elastic wave velocity of ground where the sand has been taken was found to correspond with the velocity calculated by use of the elastic moduli. The elastic constants of the back filling were found in proportion to the depth. From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

4198. Zhenishek, N. N., Theory of calculations for centrifugal dust separators with rotary action (in Russian), *Vodosuabzbenie i San. Tekbnika* no. 1, 32–36, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12616.

It is asserted that centrifugal dust separators of the rotary type can in a number of cases be effectively adapted for use in the first stage of air purification.

The following advantages of centrifugal dust separators with rotary action are indicated in comparison with other centrifugal apparatus: (1) the compactness of the appliance; (2) a higher degree of purification of the air; (3) lower running costs.

Theoretical questions relating to the evaluation of centrifugal dust separators with rotary action are examined. A deduction is given for the equations of motion of the dust particles for the straight-bladed rotor of the dust separator. It is noted that when studying and making comparisons between types of the various structural features of centrifugal dust separators with rotary action, they can be subdivided into four groups. In dust separators of the first group the air being cleansed undergoes a spiral motion along the channel of the leather casing about the axis of rotation of the wheel. In those of the second group the particles of dust move in a helical manner, while the air itself flows along the axis of the impeller with a constant velocity, simultaneously revolving round this axis with some angular velocity. In the third group the air is sucked into the interior of a revolving drum through vents in its lateral surface. The dust particles separate out from the cleansed flow in a direction radial to the periphery. In the fourth group the separation of the dust particles from the dust-laden air is based on the joint use of Coriolis' forces and centrifugal forces when, as the result of their action, the dust particles settle on the blade surfaces of the wheel.

Schematic plans are drawn up for the dust separators in each group and approximate methods are given for making the calculations. An example of the calculations illustrates the efficiency of air purification in a centrifugal dust separator with a rotary action in comparison with that of a cyclone type. It is shown that the overall dimensions of the cyclone are 3–4 times as great as those of the centrifugal dust separator with rotary action, with less efficient purification of the air and less economic operation.

G. E. Khudyakov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4199. Dzyadzio, A., Determination of the pressure loss when powders are being transported in vertical pipes (in Russian), Mukomol.-elevat. Prom-st. no. 8, 18–22, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11773.

An investigation was made of the pressure losses in vertical tubes of diameters of 50, 70, 96, 119 and 150 mm when moving the products of the milling industry pneumatically. The general loss of pressure H on the portion of steady motion can be presented in the form $H = H_0 + H_1 + H_2$. Here H_0 is the pressure loss of clean air, H_1 is the loss in lifting to a height l, and H_2 is the additional loss due to friction caused by the presence in the air of a solid suspension

$$H_0 = \lambda \frac{l}{d} \frac{\gamma v^2}{2g}, \quad H_1 = \gamma \mu l$$

$$H_2 = \lambda_M \mu \frac{l}{D} \frac{\gamma v^2}{2g}$$

where μ is the concentration of solid product in the air in kg/kg, γ is the specific gravity of the air, v is the velocity of the air in m/secs, λ is the coefficient of resistance for clean air. On the basis of his own experiments, author finds that

$$\lambda_M = 2.74.10^{-3} \left[\frac{\psi}{(1-\psi)^2} \frac{vD}{\nu} \right]^{0.3} \left(\psi = \frac{v^0}{v} \right)$$

In that formula ν is the kinematic viscosity of the air, v^0 is the velocity of twist, v is the velocity of the air. The supplementary resistance on the section of dispersal is expressed by the formula

$$H_3 = \mu\beta \frac{\gamma v^2}{2g}$$

where β is the coefficient depending on the coarseness of the product being conveyed. At the end, a nomogram is given for making the calculations for the pneumatic transport of grain and milled products in vertical tubes.

A. A. Armand

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4200. Gebhardt, H., Drop sizes with swirl-nozzle atomization (in German), *Brennstoff-Wärme-Kraft* **10**, 8, 361–366, Aug. 1958.

Experimental determination of drop size distribution in sprays, using swirl nozzle and heavy fuel oil, is made by exposing, for a short time, a glycerine-covered microscope slide to the spray. Droplets of 1-micron size were found at all injection pressures. Experiments were made also with direct photography with spark illumination, the light duration being about 1.5×10^{-6} sec. The largest drops were in the 50 to 1000-micron range. Author corroborates the finding of Troesch that the largest drops are characteristic for the type of atomization. The largest drop size represented as a function of atomizing pressure gives hyperbola-like curves, with the atomized liquid as parameter. Viscosity has important influence on the drop size.

The results are represented as a nondimensional expression for drop size, as a function of the Weber number expressing the characteristics of the swirl nozzle. From these data a nomogram has been constructed whereby the maximum drop size can be determined for an atomized liquid of known characteristics. Apparatus is illustrated and described, samples of spray photos are shown; calculation of characteristic quantities and construction of charts are explained.

This is a detailed investigation, giving also a background of previous researches, and the significance of the findings for practical applications.

K. J. DeJuhasz, Germany

4201. Kuhn, W., Spontaneous breakup of liquid cylinders into small spheres (in German), *Kolloid Z.* **132**, 2/3, 84–99, Feb./Mar. 1953.

A long, extended liquid cylinder can, under the influence of surface tension, contract not only into one sphere but can, indeed it must, break up spontaneously into a series of small spheres. It is shown that an extended circular cylinder is unstable for small constrictions or swellings of its surface if the extent of disturbance in the axial direction is greater than the cylinder radius; but it is stable when the extent of disturbance is smaller than the cylinder radius. The breakup into a multiplicity of spheres is effected by heat interchange which produces initial constrictions, without any promoting or resisting effect by the surface tension; subsequently these initial constrictions are completed by the surface forces.

The time is estimated which is necessary for generating, by the Brownian forces and against the viscous resistance of the liquid cylinder, an initial constriction of sufficient length and depth that through the interfacial forces, in a further time interval, complete cutoff takes place. The sum of the two time elements (that for generating the initial constriction plus that for completing same) equals the time within which a spontaneous breakup of the cylinder into smaller particles must take place. This is represented by an equation and by a tabulation, assuming that for the initial constriction by the Brownian movement also several other simultaneously occurring mechanisms are responsible. The total time thus determined represents the upper limit for the life of the cylinder, inasmuch as with other additional disturbances a more rapid breakup of the cylinder into drops can be expected.

According to these concepts macroscopic cylinders also break up into a series of small spheres in finite times as a consequence of the Brownian movement, the effect of which can be observed otherwise only in the microscope or ultramicroscope. This is a clear and thorough treatment of the subject.

K. J. DeJuhasz, Germany

4202. Kimura, K., The analytical evaluations of rate of suspended load by H. Rouse and H. Ismail (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 58, 50–54, Sept. 1958.

The rate of suspended load in the open channel flow may be evaluated from integration on the product of concentration of suspended load and the velocity of the flow, at each point in the depth.

In this paper the analytical evaluation of the rate of suspended load in the wide open channel is calculated by using beta function and series expansion. An example of this evaluation using data of the Mississipi river by E. W. Lane and A. A. Kalinske is given.

From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineers

Porous Media

(See also Revs. 3716, 3871, 3960, 4203)

4203. Maksimov, V. S., Hydromechanical calculation for the filtration through an earthen dam with an impermeable screen and front of the dam spillway (in Russian), *Trudi Kuibyshevsk. Inzh.-stroit. In-ta* no. 4, 185–191, 1957; *Ref. Zh. Mekh.* no. 11, 1957; Rev. 12914.

When making this investigation author breaks up the filtration flow into three parts; the portion of the thrust flow in the front of the dam spillway fragment, the portion of the thrust flow bounded above by the screen, and the portion of the impressurized flow between the screen and the drainage. Using for the first fragment the hydromechanical solution of N. N. Pavlovskii, for the third fragment, the solution of F. B. Nel'son-Skornyakov, and making for the second fragment an independent investigation, author obtained a comparatively simple solution for the given problem. Comparison with the results of tests made on the EGDA apparatus shows that the proposed method of calculation gives divergences within the range of 8–14% and tending toward the conservative side. A nomogram is proposed for the determination of the modulus of shape in order to simplify the calculations, and the sequence for the calculations is provided. The range of practical application of the proposed method appears to be limited to a certain extent, as impermeable screens and front of the dam spillways are practically nonexistent.

A. A. Uginchus

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

4204. Piskunov, N. S., Problem of the filtration of a liquid in a layer, heterogeneous in regard to power and permeability (in Russian), *Trudi Vses. Neftegaz. N.-i. In-ta* no. 8, 232–249, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12922.

A sufficiently simple approximate method is described for the calculations for the working of oil-bearing strata, in conditions of heterogeneity of the layer, which permits a qualitative evaluation of the observed phenomenon and a description with a sufficient degree of accuracy of its quantitative side. The equation for the filtration of a liquid in a heterogeneous layer was deduced and the following questions were examined: (1) the applicability of the solutions of the parabolic equation (the equation for an elastic regime) for an infinite region when investigating the working processes of finite layers; (2) the possibility of replacing a group of working wells by a single enlarged well; (3) the computation of pressure differences when a finite layer is replaced by an infinite layer; (4) the filtration in a heterogeneous layer in which the permeability depends on the polar radius-vector and does not depend on the polar angle; (5) the inflow of petroleum into a battery of working wells and the movement of the forced liquid in a layer, heterogeneous as regards power and permeability. It was established that, in conditions of authentic deposits, when the oil is spread over distances measurable in tens of kilometers, while outside the petroleum zone there is a water region, the theory of calculations evolved for the infinite layer is applicable in full. This is true for sandstone layers of smaller dimensions, if one takes into account that together with the extraction of the liquid there is a forcing of liquid into the layer. Here the error in the determination of the pressure by means of the formulas of the infinite layer will be reaching its maximum on the boundary of the finite layer, where, when the size of the layer is sufficiently large, it is insignificant. Numerical examples are examined.

P. F. Fil'chakov

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

4205. Shestakov, V. M., Calculations for filtration through earthen dams on a permeable interlayer (in Russian), *Gidrotekh. Stroit.* no. 1, 42–46, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12915.

An approximate method is put forward for the calculations of filtration through an earthen dam, in whose foundation there is an interlayer of more permeable soil of finite depth, the operative condition being that the permeability of the dam shall be less than the permeability of the interlayer ($k_1 < k_2$). For the purpose of solving the given problem author makes a separate investigation of the upper wedge of the dam and assumes that the increased discharge in the interlayer is made at the expense of the outflow of water from the upper wedge portion along the vertical planes. To determine the discharge in the interlayer, differential equations are built up, the solutions for which are given as Bessel functions. Lower than the upper wedge part of the dam the filtration flow is conditionally divided by the horizontal line of the current, coinciding with the boundary of the division of the soils. From the joint solution of the equations of the upper wedge of the dam and its lower part, in the accepted conditions of flow drainage in the "lower water," an expression is obtained for the determination of the thrust in the foundation of the end vertical section of the upper wedge. Tests were carried out on the EGDA apparatus to check the proposed method of calculation and to investigate the question of the best position for the channel or grooves in the interlayer, designed for reducing the filtration discharge. The results of some experiments are given.

M. M. Semchinova

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

4206. Romanova, E. Ya., Influence of the formation of fissures in the front of a dam spillway on the filtration in the dam's foundation (in Russian), Questions relating to filtration calculations of hydrotechnical installations, no. 2; Moscow, Gos. Izd-vo Lit. po Str-vu in Arkhitekt., 1956, 5–46; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12912.

A short review is furnished of the existing investigations of analytical methods of computing the effect of crack formation on the filtration in the dams' foundations, of the results of analytical calculations and modelling on the EGDA apparatus, of investigations on the filtration in the foundations of projected and actual hydroinstallations in the presence of fissures in the front of a dam spillway, and of observations on existing installations. The work done brought the author to conclude that the formation of fissures in the above circumstances causes slight deterioration in the conditions of work of the subterranean contour only when there is direct overlying below the spillway and body of the dam of the strata of small water permeability. In all other cases the fissure causes a sharp increase of filtration pressure and increase of the filtration discharge, when the most dangerous effect appears to be that produced by the empty (one not filled with earth) fissure which may completely destroy the beneficial effect of the front of

the dam spillway. Consequently when carrying out the construction of long front of the dam spillways special steps and precautions have to be taken to see that there is effective union between the front of the dam spillway and the main body of the dam.

N. V. Danil'chenko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4207. Nel'son-Skornyakov, F. B., Filtration through a dam with a convex curvilinear supporting slope on a permeable foundation lying under a curvilinear inclined water-resistant stratum (in Russian), *Trudi Mosk. In-ta Inzh. Zh.-d. Transp.* no. 88/89, 100–114, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12911.

A hydromechanical method is described for solving the problem of filtration through an earth dam having a curvilinear supporting slope and a curvilinear water-resistant stratum. The equations for the supporting slope and lines of the water-resistant layer are determined from the condition that their images within the Zhukovskii "functions" zone must be, respectively, inclined and parallel to the actual axis by means of straight lines. Particular cases are examined. For the case most frequently met with in practice, of a soil T with a small depth of water permeability, an approximate formula is obtained for the determination of the full filtration output

$$Q = kH\,\frac{\pi}{2\ln 2 + (\pi L/T)} = \frac{kH}{0.441 + (L/T)}$$

where L is the horizontal projection of the curved depression, K the filtration coefficient, H the actual support (the value L in the method described is the calculating parameter, which is preliminarily given). This formula guarantees the accuracy required in practice if the conditions $L/T \geqslant 0.5$, $H/T \leqslant 3$ are fulfilled. In addition, formulas are deduced in parametric form for the construction of the hydrodynamical network of motion. For illustrative purposes hydrodynamical networks were constructed (over 10%) for the two earth dams.

P. F. Fil'chakov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4208. Nel'son-Skornyakov, F. B., Filtration through a dam with horizontal drainage on a permeable foundation of infinite depth with no water in the "lower water" (method of delimited cases) (in Russian), *Trudi Mosk. In-ta Inzh. Zh.-d. Transp.* no. 88/9, 84–99, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12910.

An investigation is carried out with the aid of a method evolved by the author, the method of delimited cases [see F. B. Nel'son-Skornyakov, "Filtration in a homogeneous medium;" Izd-vo "Sovetskaya nauka," 1949] of the filtration through an earthen dam with horizontal drainage on a permeable foundation of infinite depth, with no water at the "lower water" level. As delimited cases an investigation is made of a dam with a horizontal supporting slope, with a curvilinear "almost vertical" slope, and with a curvilinear slope "approximating the 1 : 1½ ratio." For each of these cases equations were obtained, in elementary functions, for a curved depression, the drawn curves for which show little variation among themselves. This permits the calculation for an earthen dam with a slope of practical outline to be substituted by the calculation for corresponding delimited dams. In the second part of the paper an investigation is made, following theoretical procedure, of the influence of the change of form of the supporting slope in the vicinity of the point of curtailment of the water of the "upper water'' on the position of the free surface of the filtration flow in the earthen dam. It was shown that cutting out sections of comparatively large size in the supporting slope of the dam in the vicinity of the point of level reduction of the water is almost entirely without influence on the position of the portion of curved depression in the vicinity of the outlet point and has only insignificant influence on the position of the curved depression in its first portion. Numerical examples are given to illustrate the results obtained.

P. F. Fil'chakov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4209. Stepanov, N. G., Calculations for three-dimensional filtration in an earth dam equipped with a diaphragm and drainage abutting water-permeable banks (in Russian), *Trudi Kuibyshevsk. Inzh.-stroit. In-ta* no. 4, 193–198, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12916.

An investigation is carried out of the filtration round an impermeable diaphragm, when the river bank is of the same soil texture as the body of the dam, while the drainage of the lower slope is carried right up to the diaphragm. Forchemer's equation for a plane unpressurised filtration is solved by the method of conforming reflections, whereby the solution is obtained in a sufficiently simple form. A more general solution of the analagous problem of the pressurised flow was given by E. A. Zamarin ["Calculations for the motion of subsoil waters," Tashkent, 1928].

V. M. Shestakov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4210. Moskvichev, A. O., Solution of a border problem met with in the theory of motion of humidity in the soil (in Russian), *Trudi Kuibyshevsk. Inzh. -stroit. In-ta* no. 3, 299–301, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12926.

A solution is put forward for one of the problems in the theory of the movement of humidity and water-soluble salts in the soil, presented in an approximate arrangement proposed by the abstractor [*Doklady Akad. Nauk SSSR* **89**, 2, 229–232, 1953; *Izv. Akad. Nauk, Otd. Tekh. Nauk* no. 10, 1369–1382, 1953]. The problem merges with the integration of the equation

$$a\,\frac{\partial^2\varphi}{\partial x^2} + b\,\frac{\partial\varphi}{\partial x} = \frac{\partial\varphi}{\partial t}$$

in the condition when

$$\varphi(x, 0) = b, \quad \varphi(l, t) = k, \quad \frac{\partial\varphi(0, t)}{\partial x} = m$$

where a, b, b, k, m are constants.

N. N. Verigin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4211. Plaksin, I. N., Klassen, V. I., Nesterov, I. M., and Miller, E. V., Resistance of a layer of mineral particles to the passage of a flow of liquid (in Russian), *Trudi In-ta Gorn. dela Akad. Nauk SSSR* no. 3, 213–238, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11793.

To calculate the resistance when a liquid is passing through a layer of mineral particles, the equation of Navier-Stokes for the laminar motion along channels with different transverse sections, is solved. The forms of sections are examined, conforming to the forms of the spaces between adjacent particles. The equation of motion is solved by the method of end differences. For the mean velocity v an equation is obtained

$$v = -\alpha\,\frac{x_0^2}{\mu}\,\frac{dp}{dz} \qquad [1]$$

where x_0 is the radius of a circle with an area equal to the area of the section of the canal, dp/dz is the pressure gradient, μ is the viscosity, α is the numerical coefficient dependent on the form of the section of the canal, equal to 0.125 for a round section, 0.14 for a square or triangular section, and so forth. The mean value is

taken to be $\alpha = 0.13$. Then the mean velocity over that section of the layer is calculated where a large quantity of particles is included. The drop of pressure on the layer is determined by the formula

$$\left|\frac{dp}{dz}\right| = \frac{189.4\,\mu v_1\,(1-\theta)\theta^{1/2}}{(d_1^2 + d_1 d_2 + d_2^2)\,(1-\theta^{2/3})^4 g} \qquad [2]$$

where θ is the firmness of the layer, d_1 and d_2 are the dimensions of the smallest and largest particles in cm. A formula is also obtained for the calculation of the velocity of the crowded fall of the particles. The formulas were checked experimentally. The tests, carried out with batches of magnetite (particle size 0.2 – 0.1 cm), galena (0.16 – 0.1 and 0.0147 – 0.0104) and copper pyrites (0.042 – 0.025) showed that formula [2] is applicable for velocities $v_1 < 1$ cm/sec^{-1}. An analysis of the results indicated that the formulas without being previously brought to a higher standard of precision should not be used for particles of insufficient firmness.

E. M. Minskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4212. Rubinstein, L. I., Determination of the situation of the boundary division of two liquids of low compressibility, filtering through a deforming porous medium (in Russian), *Sb. Tr. Ufimsk. Neft. In-ta* no. 1, 75–108, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11791.

The theorem of the existence and regularity of solution of the following border problem is proved:

$$\frac{\partial^2 p_1}{\partial \xi^2} = \frac{\partial p_1}{\partial \tau} \text{ when } -\infty < \xi < y(\tau)$$

$$a^2 \frac{\partial^2 p_2}{\partial \xi^2} = \frac{\partial p_2}{\partial \tau} \text{ when } y(\tau) < \xi < 0$$

$$p_i \Big|_{\tau = 0} = \varphi_i(\xi) \qquad (i = 1,2), \qquad \frac{\partial p_2}{\partial \xi}\Big|_{\xi = 0} = \psi(\tau)$$

$$p_1 \Big|_{\xi = y(\tau) - 0} = p_2 \Big|_{\xi = y(\tau) + 0}$$

$$\lambda \frac{\partial p_1}{\partial \xi}\Big|_{\xi = y(\tau) - 0} = \frac{\partial p_2}{\partial \xi}\Big|_{\xi = y(\tau) + 0}$$

$$\frac{\partial y}{\partial \tau} = -\frac{\partial p_1(y(\tau), \tau)}{\partial \xi} \qquad y(0) = -1$$

Functions $\varphi_i(\xi)$ $(i = 1,2)$ are taken as three times and $\psi(\tau)$ as twice continuously differentiable everywhere in the region of their determination. To this border problem is brought the problem of determining the dividing boundary of two liquids of small compressibility, filtering through a deforming porous medium; or, otherwise stated, for instance, the problem of determining the position of a water-petroleum contact in a homogeneous petroleum stratum with an elastic regime in a single-dimensional process of filtration. It is essential to determine the functions of pressure p_1 and p_2 and the division boundary $\xi = y(\tau)$. This set boundary problem, with the aid of Green's functions, converges with a system of integral equations which is solved by the method of successive approximations. The singleness of the obtained solution is demonstrated, and also its equivalence to the solution of the initial boundary problem in the condition where τ is sufficiently small.

G. S. Salekhov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4213. Rasulov, M. L., A problem in subterranean hydromechanics (in Russian), *Nauch. Zap. L'vovsk. Politekhn. In-ta* no. 38, 66–89, 1956 (1957); *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11792.

The problem is investigated of the re-establishment of pressure in the water occurring below the petroleum layer after the stoppage of pumping of the well in the arrangement produced by I. A. Charnyi. Here it is assumed that the well with radius a is situated at the center of the circular layer, divided by a concentric circle into two ring-shaped zones, having different permeabilities. It is assumed that in the layer an elastic regime prevails, capable of being described by Fourier's equation. The original conditions are taken in the form of arbitrary functions $\varphi(r)$, different for both zones of the layer and continuous, together with their derivatives, up to the second order. The boundary conditions are taken in the following form: on the outer contour of the layer, the conditions of the first order (pressure $p_\kappa = \text{const}$); on the boundary dividing the zones of different permeability, the conditions of the fourth order (continuity of pressure and flow of liquid); and on the surface of the well, conditions of the form

$$\frac{\partial p_1(a, t)}{\partial r} + \alpha \frac{\partial p_1(a, t)}{\partial t} = 0 \qquad [1]$$

where $p_1(r, t)$ is the pressure in the first zone of the layer, adjoining the well, $\alpha = \text{const}$. Condition [1] evaluates the filling of the well with liquid in the process of re-establishment of the pressure in the water occurring below the petroleum layer after stoppage of pumping of the well. This problem is divided by the author into two auxiliary problems, namely (a) in conditions indicated above of heterogeneous boundary conditions and initial conditions equalling zero; (b) in homogeneous boundary conditions ($p_k = 0$) and original boundary conditions not equal to zero. A general scheme is then put forward for the application of the method of deduction to the solution of mixed problems of similar type and proof is adduced for the theorem of existence of a solution for the separated-out supplementary problems.

N. N. Verigin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4214. Pakharev, N. O., Some cases of filtration from axially symmetrical water reservoirs (in Russian), *Nauk. Zap. Kievsk. In-ta* **13**, 8, 115–120, 1954; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11782.

A study is made of depression curves, and an approximate method is given for the determination of the discharge of a liquid when being filtered off from unsupported axially symmetrical reservoirs. The investigation is carried out on the basis of certain variational theorems, which emerge from the general theorem on the conservation of regions for elliptical systems of differential equations as shown by G. N. Polozhim [*Mat. Sb.* **32**, 1953, no. 3]. Here the concept is made use of, introduced by the author, on the so-called distorted vector of velocity of filtration, to cover the case of axially symmetrical filtration. Numerical examples are examined.

G. S. Salekhov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4215. Shakhovkin, V. M., A volumetric arrangement for a porous medium (in Russian), *Trudi Mosk. Neft. In-ta* no. 16, 23–31, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11795.

To clarify the phenomena observed when petroleum is being displaced by water an analysis is submitted of the motion of the boundary of two immiscible liquids in the proposed model of the porous medium. The model of the porous medium is in the form of sets of intersecting capillary tubes, making up an orthogonal three-dimensional network. With the help of such a model, control figures of values are established for the maximal and minimal

yields. These figures are expressed as the relation of the number of pores in which there is motion of the boundary of the two liquids to the general number of pores. A qualitative relation is established for the values of maximum and minimum yields of petroleum ensuing from different regimes of displacement, and the degree of homogeneity displayed in the porous medium, when petroleum is being displaced while wetting the stratum with water, badly or well. The deductions presented in the paper are based only on logical discussions and are not supported by calculations and experiments. Again, no recommendations are put forward for the practical use of the given control figures; nor is it shown in what way the actual porous medium can be replaced by the model medium. It should be noted that an analogous plan for a porous medium has been proposed by Owan [*J. Petrol. Technol.* **4**, no. 7, 1952].

V. I. Aravin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4216. Guseinov, G. P., Application of a specific approximate method to the problems of the theory of filtration (in Russian), *Uch. Zap. Azerb. In-ta* no. 5, 3–8, 1955; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11789.

An approximate method is proposed for the solution of the equations for an irregular radial flow of a liquid in an elastic regime of filtration. The equation

$$a^2 \frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial p}{\partial r} \right) = \frac{\partial p}{\partial t} \qquad [1]$$

is replaced by the following

$$a^2 \frac{1}{r} \frac{d}{dr} \left(r \frac{dp}{dr} \right) = F(t) \qquad [2]$$

where

$$F(t) = \frac{2}{R^2} \int_{r_c}^{R} \frac{\partial p}{\partial t} r dr$$

that is, the right-hand side of Eq. [1] is replaced by its mean value along the surface. The solution of Eq. [2] is sought with boundary conditions of $p = p_0$ when $r = R$; $p = p_c$ when $r = r_c$. Then $F(t)$ is determined from the condition $\partial p/\partial r = 0$, when $r = R$. The second phase is then investigated; this commences at the moment when the depression reaches the impermeable boundary. As an example the case is examined of a given yield $Q(t)$. Author shows that the method proposed gives more exact results than the method of successive replacement of stationary conditions.

V. L. Danilov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4217. Egorov, A. I., Loss of pressure in the filtering sand layer when rapid action quartz filters are flushed (in Russian), Investigations in water pre-treatment; Moscow, Gos. Izd-vo Lit. po Str-vu i Arkhitekture, 1955, 84–92; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12939.

Author divides the pressure losses in the suspended layer of sand H, when the filter is being flushed from the bottom upwards, into the loss of pressure on the suspension of sand b_i and loss of pressure b_w on the overcoming of vortex resistances, appearing due to the movement of the water through the layer of suspended sand $H = (b_i + b_w)\, l$, where l is the thickness of the sand layer m. For the components of pressure losses the following formulas are introduced: $b_i = (\gamma - 1) \times (1 - m_e)$; $b_w = k(w - \alpha)$, where γ is the specific weight of the sand, m_e is the porosity when freely added to the water, w the intensivity of the flushing of the sand, 1/sec m^2, α the critical intensivity of the flushing at which the sand begins to go over into suspension, m/sec m^2, k the coefficient equal to 0.0175 for filters with a slit drainage without sand layers and 0.008 for filters with sand layers.

V. A. Klyachko

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4218. Chankvetadze, G. G., Elastic medium with a cylindrical cavity (in Russian), *Trudi Gruz. Politekhn. In-ta* no. 6(47), 38–46, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12984.

The stressed and deformed condition of an infinite elastic medium with a cylindrical cavity and loaded at some finite portion with an even internal pressure is investigated. The solution is carried out by the methods of the mathematical theory of elasticity and is presented in Legendre polynomials. There is a significant number of misprints in the text.

S. V. Boyarshinov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4219. Aleksandryan, V. V., Calculations for incomplete pressure and non-pressure wells with an impermeable bottom (in Russian) *Izv. Akad. Nauk ArmSSR, Fiz.-Matem. Estestv. i Tekh. Nauk* **9**, 10, 65–70, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12919.

An hydraulic method is advanced for the calculations of the yield of an incomplete well in conditions of a pressure and pressure-no-pressure inflow into a layer of undelimited power. In deducing the calculation formulas for the well's yield the author, following S. V. Novokreshchenov [Tr. Sredneaz. Politekhn. In-ta, Tashkent, Gosizdat UzSSSR, 1955, 239–231], accepts the arbitrary assumption that, at a given stratification of the water resistance and impermeability of the well's bottom, the active zone of the water-bearing stratum is delimited below the line of flow appearing as a mirrored reflection of the curved depression. For the yield of a pressure well the formula is obtained $Q = \pi k s(2l + s)/ln(R/r)$, where s is the depth of the reduced water level in the well, l is the penetration of the well into the water-bearing stratum. For the yield in the case of a pressure-no-pressure flow the formula is given $Q = \pi k(2Hs - m^2)/ln(R/r)$, where m is the pressure under the cover of the layer. An evaluation of the proposed formulas is accomplished by means of a comparison of the yield of two wells, calculated with the aid of the author's formulas and obtained by measurement in field conditions.

M. M. Semchinova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4220. Danilov, V. L., The simultaneous control of several contours of oil-bearing layers taking into account the difference in viscosity of water and petroleum (in Russian), *Izv. Kazansk. Fil. Akad. Nauk SSSR, Ser. Fiz.-Matem. i Tekh. Nauk* no. 9, 13–33, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12921.

Several methods of solving the problem of simultaneous control by transfer of several contours of oil-carrying layers to a horizontal homogeneous layer of constant capacity are investigated. It is assumed that in the layer there is a certain number of finite single-bond regions, saturated with a liquid having a viscosity μ_c (crude oil), while outside these regions the layer is saturated with another liquid having a viscosity μ_w (water). Under the action of forcing and working wells, distributed in a known pattern over the layer, a transfer of level takes place in each region. The question arises: at which yields of the active wells do the transfers of the separate levels approximate most closely to the given principles of transfer (contraction). The study appears to be a generalization of the known investigations of G. S. Salekhov [*Izv. Kazansk. Fil. Akad. Nauk SSSR, Ser. Fiz.-Matem. i Tekh. Nauk*, no. 8, p. 129, 1955, and of the author *Izv. Kazansk. Fil. Akad. Nauk SSSR, Ser. Fiz.-Matem. i Tekh. Nauk* no. 8, 30–54, 1955]. For the solution of the problem the known methods of the theory of the logarithmic potential are applied. The application of the method is demonstrated

by an example of the calculations in the case of the problem of control by the movement of two round contours of oil-bearing strata.

V. P. Pilatovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4221. Trofimenkov, Yu. G., Calculations for water-collecting pits taking into account the intervals between pumping out (in Russian), Experiment in the artificial lowering of sub-soil water level when building hydroelectrical power stations, Moscow-Leningrad, Gosenergoizdat, 1956, 101–113; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12917.

On the basis of some theoretical conceptions and comparison with experimental results of work done by the EGDA method, author obtained empirical formulas for calculations for water-collecting pits taking into account the intervals of time between their being pumped out. In the case

$$\delta_c = \frac{H - h_0}{\eta_0 \ln \frac{R}{r_0}} \frac{4}{\pi} \left(1 - \frac{h_c}{H}\right)^{0.5}$$

where

$$\eta_0 = \rho_0 \frac{K_1(\rho_0)}{K_0(\rho_0)}, \quad \rho_0 = \frac{2\pi r_0}{H}$$

The signs used are the customary ones: $K_0 K_1$ are cylindrical functions. For the determination of the flow of the incomplete pit the coefficient for incompleteness of the pit is introduced

$$\alpha = \frac{Q_H}{Q_c} = 1 - \frac{A_H \delta_H}{S}, \qquad A_H = \frac{c}{h_0 + \delta_c}$$

where Q_c, Q_H are the flows of the complete and incomplete pits, respectively, c is the distance from the water-resistant layer to the bottom of the pit, S is the depth of reduction in water-level, δ_H is the interval of pumping out determined by the formula

$$\delta_H = \delta_c \Big/ \left[1 - A_H \left(1 - \frac{\delta_c}{S}\right)\right]$$

The formula obtained by the author for the determination of the ordinate of the curved depression z is applicable when $r/R \geqslant 0.2$. For the incomplete pit

$$Z_H = \delta_H \left(1 - \frac{A_H}{2}\right) \frac{K_0(\rho)}{K_0(\rho_0)} + \left\{H^2 - \frac{Q_H}{\pi k} \ln \frac{R}{r} - \delta_H H A_H \frac{K_0(\rho)}{K_0(\rho_0)} + \left[\frac{\delta_H A_H}{2} \frac{K_0(\rho)}{K_0(\rho_0)}\right]^2\right\}^{-1/2}$$

when $c = 0$ and $A_H = 0$, this formula is transformed into the formula for the complete well. In the remaining cases the difference in the formulas for the determination of the flow and the ordinates of the curved depression consists only in the values of the coefficients A_H and i, which take into consideration the types of pits and the conditions for their interaction. As an example author puts forward the results of calculations made by his proposed formulas for three types of single pits. The close correspondence of the curves for depression with the data of V. I. Aravin's experiments for small values of r_0/H is noted. A comparison of the values for discharges of an incomplete well gives good conformity with I. A. Charnyi and divergence from the formulas of V. D. Babushkin and P. P. Arnov.

M. M. Semchinova

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Geophysics, Hydrology, Oceanography, Meteorology

(See also Revs. 3857, 3964, 4122, 4123)

Book—4222. Scheidegger, A. E., Principles of geodynamics, Berlin, Springer-Verlag, 1958, xi + 280 pp. DM 49.60.

Geodynamics is based on application of physical theories to findings of the geological sciences. No scientist has full information on recent developments in both fields. The author is familiar with the mechanical problems involved, but will hear objections to some of his geological assumptions. His approach is well stated at the end: The only way open to the investigator is to make various guesses as to the possible cause of geological phenomena and to test the consequences. This, he concludes, has not yet led to entirely satisfactory results.

After summarizing geological, geochemical and geophysical findings (62 pp.), author discusses "the mechanics of deformation" (50 pp.), stressing "Rheology of the earth: the basic problem of geodynamics." He believes that the earth's material behaves roughly as a Kelvin body with strength limit, for processes lasting from a few hours to thousands of years, but as a Bingham body if they last longer. Factual and hypothetical effects of the earth's rotation, hypothesis on the history of oceans and continents and on orogenesis, including convection currents and continental drift, cover 86 pages. Dynamics of faulting and folding (29 pp.) and of other features (21 pp.), including postglacial uplift, conclude the book, which can be strongly recommended to specialists in applied mechanics, who will find many stimulating ideas.

B. Gutenberg, USA

4223. Ifrim, M., Contributions to the problem of building vibrations during earthquakes (in English), *Acad. Repub. Pop. Romine, Rev. Mecan. Appl.* **3**, 2, 151–168, 1958.

Paper deals with theoretical aspects connected with the dynamic characteristics of structures subjected to seismic action.

For evaluating the natural frequency of vibration, author proceeds from the energy principle and gives general formulas for the dimensionless coefficient ζ which multiplies the dimensional factor in the expression of coefficient ω. The expressions of ζ are function of the relative static-geometrical characteristics of the structure and result from a very simple form. The suggested formulas avoid the writing of complicated equations whose solving is laborious and might be a source of errors. It is shown that these formulas determine the upper limit of the natural frequency, the lower limit being given by Geiger's formula. From the analysis of the interval of frequency variation, an improved formula is presented whose results are very close to the exact values. Theory is extended to the case of a structure which rocks on an elastic soil. Further, the calculus of the seismic loads is presented on the basis of the natural frequency of vibration and of the normal modes when the motion caused by the earthquake is known.

Two samples of calculation are finally included.

M. Soare, Roumania

4224. Nazarov, A. G., Simplified method for calculation of seismic stability in installations (in Russian), *Izv. Akad. Nauk ArmSSR, Fiz.-Matem Estestv. i Tekhn. Nauk* **9**, 10, 55–63, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11942.

A method is described for the computation of the first and succeeding forms of vibrations, using the standard spectrum curve for

seismic acceleration. Starting from the value of the force of inertia, corresponding to an arbitrary form of free vibrations, author supplies an expression for the determination of a distributed seismic force

$$S = \sum \frac{r_i}{g} q(x) \delta_i X_i$$

where r_i is the seismic acceleration brought in, which depends on periodicity T_i of the free vibrations, responding to the i-form of vibrations; g is the acceleration due to gravity; $q(x)$ is the distribution of the load on the installation; δ_i is a coefficient; X_i is a fundamental function. For the first form of vibrations the seismic load is equal to

$$S' = \frac{r_i}{g} q(x) \delta_i X_i$$

and its value

$$S'' = \frac{\eta(T)}{g} q(x)[1 - \delta_i X_1]$$

agrees (approximately) with the higher forms of vibrations.

Sh. G. Napetvaradze

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4225. Barov, L. I., The influence of height in samples of firm rocks on their time resistance to crushing (in Russian), *Zavod. Lab.* **22**, 11, 1352–1354, 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9483.

Tests were made in uniaxial compression on 300 samples of firm rocks of 51 different species, with varying aspect ratios of height to diameter of the sample, within the limits of 0.27 to 1.78.

It is found that with increasing height of the samples their strength decreases 2½ to 4 times, and subsequently becomes constant.

M. M. Protod'yakonov

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4226. Matveev, K. V., Local erosion at the head of the traverse (in Russian), *Trudi Mosk. In-ta Inzh. Zh.-d. Transp.* no. 88/89, 139–149, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12705.

It is proposed to determine the greatest depth of the bottom of fine-grained sand at the head of a traverse by means of the empirical formula

$$h_p = 27 K_1 K_2 \frac{v_m^2}{g} \tan \frac{\alpha}{2}$$

$$\log K_1 = -1.215 \sqrt{\frac{v_m^2}{gb}}, \quad \log K_2 = -0.087m$$

Here b is the projection of the mean length of the traverse on to the normal to the axis of the flow, m is the coefficient of the laying of the slope of the traverse, $\alpha^\circ < 90^\circ$ is the angle of flowing in of the stream on the traverse (with $\alpha^\circ < 90^\circ$ tan ½ α° is taken to be equal to 1); the local velocity of the flowing in of the stream on the traverse coming in to the formula is determined by the formula

$$v^2 = v_0^2 \left(1 + 3.2 \frac{Q_n}{Q}\right)$$

where Q_n is the rate of flow of water passing along the covered part of the live section up to the structure of the installation, Q is the full amount of the whole flow and v_0 is the mean velocity of the flow. The recommendations were made on the basis of experiments in a rectilinear trough of rectangular section 150 cm wide and 700 cm long on the scouring of Lynberets sand, $d = 0.33$ mm at traverses (without aprons and other devices), covering from 10% to 40% of the width of the trough. The measurement of the depths was carried out after the completion of the experiments, the settlement of suspended matter and the draining off of the water (and not during the time of the experiment). Comparisons of the calculations made by the given formula with the published recommendations of other investigators and with data derived from nature are not given in the paper.

M. S. Vyzgo

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4227. Budagovskii, A. I., Dependence of evaporation on meteorological conditions and the humidity of the soil (in Russian), *Trudi Aralo-Kaspiisk. Kompletksnoi Ekspeditsii Akad. Nauk SSSR* no. 6, 158–193, 1956; *Ref. Zh. Mekh.* no. 7, 1957, Rev. 8042.

In the first part of the work an investigation is made of the meteorological conditions of evaporation from the soil, in its "pure" form appearing as evaporation from excess humidity of the soil (the first stage of evaporation). The evaporation was determined as the residual term of the equation of thermal equilibrium, when the turbulent flow of heat entering into this equation was determined by Monin's formula. Analysis showed that the 24-hour totals of evaporation E_0 from the excessively humidified soil are linked with the mean 24-hour values of humidity deficit by a simple relation $E_0 = \alpha d$ [8], the relation becoming closer after transfer to the 5-day sliding mean. The proportionality coefficient α in formula [8] appeared to be independent of the wind velocity, notwithstanding the usual interpretation on this point. Nonetheless, wind does influence evaporation, but this influence is looked upon as the wind's influence on d. A commentary is given of this result of the analysis of the observations.

The second part of the paper is devoted to the mechanism of the movement of water in the soil during evaporation, an essential for the study of the second stage of evaporation—evaporation from an insufficiently humidified soil. Analysis is based principally on the data given in the literature. Three types of humidified soils are investigated, and, in correspondence with them, the movement of capillary water, the movement of "suspended" water and the movement of "suspended" water linked with the capillary fringe. It was shown that the velocity of motion of "suspended" water at the surface of the soil q_0 is connected with the humidity W by a linear relation $q_0 = \alpha(W - W_p)$ [29] where α is the parameter, W_p is the so-called "humidity disruption point of the capillaries." At the same time the decrease of humidity in the soil in a time period T is recorded according to the exponential principle as $W - W_p = (W_n - W_p) \exp(-\alpha T/y_0)$ where y_0 is the thickness of the humidified layer of the soil, W the initial humidity, while the evaporation E is linked with the soil humidity W by the formula $E = b(W - W_0) E_0$ [32] where E_0 is the evaporation from the excess humidity of the soil (evaporability) from [8], b an undimensional parameter, W_0 the bound humidity.

The relation obtained in the study on the basis of the analysis of the observed data has been put forward previously by M. I. Budyko [In the collection: Problems regarding the hydrometeorological effectiveness of field protection—tree shelter belts, Gidrometizdat, 1950] from theoretical considerations. Formula [32] is suitable for describing the second evaporation stage, when $W \leq W_k$, where the "critical" humidity W_k is determined by the condition of parity of evaporability E_0 and the velocity of motion of the water q_0. In the third part, the standard behavior is examined

of the changes in reserves of humidity of the soil and also of the total evaporation over some given period of time.

L. S. Gandin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4228. Laikhtman, D. L., and Timofeef, M. P., Method of calculation of the evaporation from the surface of delimited water basins (in Russian), *Meteorol. i Gidrologiya* no. 4, 19–23, 1955; *Ref. Zh. Mekh.* no. 7, 1957, Rev. 8068.

Empirical and theoretical formulas are advanced for the calculation of evaporation off the surface of water basins. Their comparison shows that the first, obtained from the data of evaporators, does not take into account the dimensions of the water basins and consequently can give significantly wrong results. The annual course of evaporation for 1954 for the Tsimlyanskii water catchment area was calculated according to the radiation balance of dryness and air temperature coming into the water basin.

E. M. Dobryshman

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4229. Krylov, Yu. M., The statistical theory and calculation of ocean wind waves. Part I (in Russian), *Trudi Gos. Okeanogr. In-ta* no. 33(45), 5–79, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12728.

In chapter I a critical review is given of the empirical and theoretical works known in the literature on wind waves. Attention is mainly centered on the theoretical investigations. Author records their defects: (1) in the deduction of the equation of energy no account is taken of the co-existence of the complete wave spectrum; (2) no account is taken of the three-dimensional character of the sea swell; (3) the correlation between the steepness and growth of the wave is not deduced from the analysis of the processes taking place on the water-air boundary, taking into account the diversity of the wave elements; (4) a total disclosure is not made of the mechanism of energy transfer from the wind to the wave; (5) no account is taken of the turbulent character of the wind current and of the change in the wind with elevation.

Chapters II and III are devoted to an exposition of a new statistical theory, free to a significant extent from the shortcomings cited above. Wind waves are investigated as turbulent pulsating motions of the surface layer of the sea caused by wind. Functions are constructed both for single and multidimensional cases of the distribution of all the basic elements of the waves. A concept is introduced regarding wave elements at a point and the elements of three-dimensional waves, and the statistical connection between them is established. Data of the measurements are given confirming the theoretical deductions. Deductions are put forward for deriving a closed system of equations for the determination of the mean components of waves in relation to the length of the wave run, the wind velocity and the duration of its action. These equations are obtained by means of application of not only the principles of mechanics but also of the functions mentioned above for the distribution of the wave elements, and are applied together with the equation of energy, the correlation between the steepness and growth of the wave and the connection between the steepness of the wave along the crest and its growth.

In this method the real three-dimensional waves on a free surface are schematically presented as three-dimensional sine waves. The correlation between the steepness and growth of the wave is deduced directly from the equations of the hydromechanics of turbulent motion in projections on the vertical axis.

Ya. I. Sekersh-Zen'kovich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4230. Fel'zenbaum, A. I., Method of full flows in the classical theory of ocean currents (in Russian), *Trudi In-ta Okeanol. Akad. Nauk SSSR* no. 19, 57–82, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12727.

The problem is investigated of steady currents in a homogeneous sea appearing as the consequence of the action of tangential pressure of the wind on the surface of the sea.

The original equations take the form of two equations of motion (in which take part terms conditioned by vertical turbulent agitation, by Coriolis force and by pressure gradients), an equation for the static state and an equation of continuity for an incompressible liquid. As a boundary condition on the sea surface, i.e. with $z = \xi$, the equality of the tangential friction of the water and the air is taken, while on the sea bed the condition of adhesion applies. On the surface of the sea a condition of continuity of pressure is assumed. The rise in level is represented by the sum $\xi = \xi_c + \xi'$. Using the equation for the static state and taking note of the fact that the inclinations of level ξ_c are governed by the static effect of the atmospheric pressure and are brought into equilibrium by the gradients of that pressure, author replaces the gradients of pressure of the liquid by the inclinations of level $(\partial\xi'/\partial x, \partial\xi'/\partial y)$, conditioned by the driving-dispersing effect of the wind.

In the result, author arrives at the following system

$$A\frac{\partial^2 u}{\partial z^2} + 2w\rho_0 \sin\varphi v = -g\rho_0\frac{\partial\xi'}{\partial x} \qquad [1]$$

$$A\frac{\partial^2 v}{\partial z^2} - 2w\rho_0 \sin\varphi u = -g\rho_0\frac{\partial\xi'}{\partial y} \qquad [2]$$

$$\frac{\partial S_x}{\partial x} + \frac{\partial S_y}{\partial y} = 0 \qquad [3]$$

Here u and v are components of the current velocity along the x and y axes, S_x, S_y are components of full flow, A the coefficient of the vertical turbulent agitation, ω the angular velocity of the Earth's rotation, g the acceleration due to gravity, and φ the geographical latitude.

To solve the problem the author first of all, from equations [1], [2], and taking into account the pertinent boundary conditions, gets expressions for u, v through the tangential friction of the wind and the inclinations of level. If a direct connection is established between the dynamic rise in level and the wind, then it is possible to obtain a nonlinear equation relating to ξ'; it should be noted that even on the assumption that the sea is fairly deep, which simplifies the equation, the problem still remains very complicated. It is possible, by the aid of equation [3], to introduce the function of full current ψ, as then all the hydrodynamic characteristics sought will be expressed through ψ. Author shows that in such a case the boundary conditions of the problem become fairly simple.

As a separate matter, a simplified method of solving the problem is given to cover the cases of a very shallow or a very deep sea. An analytical solution of the problem is put forward for a number of particular cases: (1) currents induced by an evenly blowing wind in an enclosed sea of constant depth; in this case $\psi = 0$ and the solution is easy; (2) currents in a rectangular sea of constant depth; this problem is solved analytically by means of the resolution of the given and sought values in a double series along the sinusoids from x and y. A solution was also obtained for the problem of the currents of a central transverse section of a sea of an elliptical shape.

A. S. Sarkisyan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4231. Lebedev, P. I., The laboratory determination of wave forces on an isolated support (in Russian), *Sb. Trudi Vses. N.-i. In-ta Gidrotekhn. i San.-tekhn. Rabot* no. 7, 115-129, 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 8961.

Experiments are described on the determination of wave action on two variants (piles and piers) of isolated supports. The value of the wave forces was measured by means of an extensometer bracket, and recorded by an oscillograph.

The results of the experiments have been converted by the similarity law, and are sufficiently close to the full-scale measurements of Gluchowsky and Wilensky [*Trudi Gos. Okeanograf. In-ta* no. 26, 1954]. The empirical formula developed by A. V. Afonsky [Thesis, MISI, 1954] is too approximate and in a number of cases contradicts the experimental results.

Drawings, photographs and tables of the results are given.

S. Z. Zhak

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4232. Fedorov, K. N., Results of modelling full currents produced by wind action on the sea (in Russian), *Trudi In-ta Okeanol. Akad. Nauk SSSR* **19**, 83-97, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12730.

Results are given of the modelling of full currents for the Bering Sea. At the basis of the modelling is the analogy between the equation of full currents caused by the wind in the sea and the equation of small deflections of a thin plate under the action of transverse loading, a matter studied by V. B. Shtokman. The equation for the field of full currents, in the case where the variation of Coriolis parameter with latitude is disregarded, has the form

$$\Delta\Delta\psi = -\frac{\mathrm{rot}_z \tau}{A}$$

where $\Delta\Delta$ is a biharmonic operator, ψ the function of full currents, $\mathrm{rot}_z \tau$ a vertical vortex component induced by the tangential pressure of the wind, A the coefficient of the horizontal turbulent agitation. An analogous form is presented by the equation of small deflections of an elastic plate $\Delta\Delta\zeta = P/D$, where ζ is the small deflection of the plate, P the intensity of the loading, D the cylindrical rigidity of the plate.

The essential point of the experiment was that the thin elastic plate, the contour of which was geometrically similar to that of the Bering Sea, was subjected to the action of loads. When this is done the field of loading should numerically reproduce the field of vortex excitation due to the tangential friction of the wind on the sea, and there should be points of coincidence in the corresponding boundary conditions. The boundary conditions for ψ appear as

$(\psi)_L = \mathrm{const} = 0, \left(\frac{\partial\psi}{\partial n}\right)_L = 0$, where L is the contour of the sea, n the normal to the sea. In order to ensure that ζ should accurately satisfy the same boundary conditions as ψ, the plate was firmly fastened along the contour L. A special type of device was built for the experiment. A description is given of the device and the experiments. The numerical value of A was determined by the Richardson-Obukhov 4/3 power law. Taking as the observation scale $l = 10^8$cm, author obtains $A = 1.5 \times 10^9$ CGS units. The experiments on modelling the full currents in the Bering Sea were made for a series of wind systems. Results of the modelling for the month of February are given. By means of successive approximations a study was carried out of the change in Coriolis parameter with latitude. It was shown that the third approximation gives a quite improbable picture, which is evidence of improper application of the method of successive approximations. The author indicates that convergence is made certain if the numerical value of A is doubled.

A. S. Sarkisyan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4233. Dmitriev, A. A., and Donchkovskaya, T. V., Observations on models of the motions appearing as the result of a frontal impact of a wave against a slope, and some ideas on the circulation caused by the oblique approach of a wave to a smooth sloping shore (in Russian), *Trudi Mor. Gidrofiz. In-ta, Akad. Nauk SSSR* **4**, 31-71, 1954; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12735.

The results are described of an experimental and theoretical investigation of the mechanics involved in the scouring of natural banks by wave currents. Attention is primarily directed to clarifying the structure of motion in the wave, particularly in the breaking-up wave. The experiments were carried out in a transparent wave tank 15.2 cm wide and 200 cm long. Waves were produced of a height of 2.5 cm, length of 30 cm and a period of 0.4 secs. The observations were carried out principally by means of a polarized light apparatus. Cinematographic pictures were taken of the wave after adding to the liquid medium a colloidal solution of vanadium pentoxide. Treatment of the film frames of successive phases of one wave period (lasting 0.034 secs.) enabled charts to be obtained of the vector fields of transfer of particles during the propagation of the wave through slopes inclined at 15° to 30°. From a scrutiny of the structure of particle motion in the wave breaking up on the slope a conception can be obtained of the removal and return of particles in separate parts of the slope. It was established that the impulse acquired by particles above the bottom in wave agitation leads to the appearance in shoal water off the shore of a current near the bottom carrying deposits to the shore. At great depths circulation currents in the opposite direction may be induced. The presence is noted of self-oscillation motions, akin in origin to discontinuous currents. A study was made of the break-up of the wave in relation to the steepness of the slopes encountered, and also of changes in the slopes due to wave action. The actual location of zones of erosion and deposit depends on the steepness of the slope. With sloping profiles (longitudinal sectional elevation) these zones tend to be further away from the surf area while the erosion is deeper.

B. Kh. Glukhovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4234. Ivanov, A. A., Recording of wave elements by means of photography from the shore and from the ship (in Russian), *Trudi Mor. Gidrofiz. In-ta Akad. Nauk SSSR* **4**, 15-22, 1954; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12736.

This is a description of slit photography applicable to the recording of wave motion. The camera used is furnished with a moving ribbon attachment and has between the lens and the sensitive paper a shutter with a narrow slit; through the latter the dividing line between the water and the air is projected onto the light-sensitive layer. During wave motion the line flickers leaving a thin track on the moving ribbon. When measuring the wave elements from the shore the principal optical axis of the lens is directed on the line of the visible horizon. The travel of the wave crests is impressed on the ribbon by lines hyperbolic in shape (in the case of a regular wave motion). The length of the wave is judged by the distance between adjacent wave crests on the ribbon in the direction perpendicular to its change of position. The period of the waves is determined by the distance between adjacent crests in the direction of motion of the ribbon. It is possible to ascertain the height of the wave, in addition to its length and period, by inserting in front of the ribbon a shutter with two slits, one of which is perpendicular to the direction of change of position of the ribbon, while the second is inclined to the first

at some angle. When recording waves from shipboard the camera is placed in gyroscopic suspension. This does away with the effect of rolling and pitching, but retains the abnormal action of continuous movement of the lens vertically, and in consequence it is not feasible to measure the height of waves from board ship.

B. Kh. Glukhovskii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Book—4235. Kresser, W., Floods of the Danube river [Die Hochwässer der Donau], Schriftenreihe des Österreichischen Wasserwirtschaftsverbandes no. 32/33, Vienna, Springer-Verlag, 1957, 95 pp. $2. (Paperbound)

Well-illustrated study of the Danube floods begins with the greatest of 1501, when up to 500,000 cubic feet of water passed Vienna per second. Particularly correct data were gathered during 135 years of permanent observations. Many gages and high-water marks on city buildings assure exact knowledge of flood crest stages and permit comparison. 25 great floods occurred during 1821–1955. Most significant flood waves are shown on 15 diagrams for gaging stations between Salzburg and Hainburg, below Vienna. A recent flood is investigated in more detail, with an isohyetal map of the drainage area in Bavaria and Austria. There are extensive publications of all data concerning that flood in Bavaria, Austria and Hungary. Views of high-water marks and overflooded valleys and cities illustrate this carefully prepared and very valuable booklet.

S. Kolupaila, USA

4236. Escande, L., Study of flood removing hydraulic structures (in Roumanian), *Studii Si Cercetari Mecan. Appl.* **9**, 4, 881–917, 1958.

Paper presents the results of experimental investigations carried out for studying a series of devices for removing floods occurring at hydraulic structures. The form of threshold and the possibility of avoiding erosion at spillways are discussed. Results obtained for spillway equipped with pillars of aerodynamic profiles are also presented. Studies on other hydraulic structures for flood removal, such as underground galleries, are included.

Finally, experiments on bottom sluices and on sluices working simultaneously as spillways and bottom sluices are described.

D. Gh. Ionescu, Roumania

Book—4237. Defant, A., and Defant, F., Physical dynamics of the atmosphere [Physikalische Dynamik der Atmosphare], Frankfurt, Akademische Verlagsgesellschaft Gmbh, 1957, xv + 527 pp.

This is an excellent book and should be of great help to all meteorologists. It is always difficult to write on a subject which is rapidly changing and expanding, but the authors have succeeded in covering systematically the whole area by incorporating the latest developments. The best way to describe the extent of the book is by listing the chapter headings:

Static of the atmosphere; General thermodynamics of the dry and wet air; Changes in state in the vertical air columns; Problems of stability and elasticity; Radiation; Kinematics; Equations of motion of the rotating earth; Simple stationary atmospheric horizontal currents; Circulation and vorticity; "Planes of discontinuity; Turbulence and exchange; Friction and turbulence in the atmosphere; Atmospherical energetic; General circulation of the atmosphere; Numerical weather prediction; and Atmospherical fluctuations.

The mathematical treatment is consistent and no undefined equations are introduced. Great emphasis has been placed upon the general circulation of the atmosphere, in which the newly discovered observational evidence is well organized.

Many references are given after each chapter.

C. B. Ludwig, USA

4238. Kertz, W., Atmospheric tides (in German), Encyclopedia of Physics, 48, Geophysics 2, Springer-Verlag, 1957, 928–981.

Section is a handy and good review on the present status of the theories and observed facts on atmospheric tides, as well as worldwide atmospheric oscillations. Contents of this review are: (1) Introduction; (2) Causes of atmospheric tides, (a) gravitation, (b) solar radiation; (3) Equations of motion and their solutions for several model atmospheres; (4) Forced oscillations, (a) gravitation (solar and lunar), (b) thermal excitation, (c) some other effects such as topography; (5) Free oscillations, and 57 references. Good summary on tidal forces by Dr. J. Bartels [AMR **12**, (1959), Rev. 1632] has also appeared in the same volume of this encyclopedia.

Reviewer believes the recent finding on tidal oscillations obtained from 300-mb transosonde data [*J. Meteorol.* **15**, 6, 566–567, Dec. 1958] is an essential progress in this field.

H. Arakawa, Japan

4239. Gubin, V. I., Wind shift with altitude (in Russian), Meteorology and Hydrology in Uzbekistan, Tasgkent, Akad. Nauk UzSSR, 1955, 111–120; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9147.

A system of differential equations is examined of the atmosphere without account of friction:

$$\begin{aligned} \frac{du}{dt} &= -\alpha\frac{\partial p}{\partial x} + lv - l'w \\ \frac{dv}{dt} &= -\alpha\frac{\partial p}{\partial y} - lu \\ \frac{dw}{dt} &= -\alpha\frac{\partial p}{\partial z} - g + l'u \end{aligned} \qquad [1]$$

In these, w, v, u, are the components of the wind velocity vector along the axes x, y, z respectively; p, α – the pressure and specific volume of atmospheric air; g – acceleration of gravity; $l = 2\omega \sin \varphi$, $l' = 2\omega \cos \varphi$, in which φ is the geographic latitude of the point, ω = angular velocity of the terrestrial rotation.

The system [1] is reduced by transformations and evaluation of the orders of magnitude, to the following:

$$\begin{aligned} \frac{d}{dt}\frac{\partial u}{\partial z} - l\frac{\partial v}{\partial z} &= (\alpha, p)_{xz} \\ \frac{d}{dt}\frac{\partial v}{\partial z} + l\frac{\partial u}{\partial z} &= (\alpha, p)_{yz} \end{aligned} \qquad [2]$$

in which

$$(\alpha, p)_{xz} = \frac{\partial\alpha}{\partial x}\frac{\partial p}{\partial z} - \frac{\partial\alpha}{\partial z}\frac{\partial p}{\partial x}$$

$$(\alpha, p)_{yz} = \frac{\partial\alpha}{\partial y}\frac{\partial p}{\partial z} - \frac{\partial\alpha}{\partial z}\frac{\partial p}{\partial y}$$

The wind shift with altitude can be approximately determined from the above system [2], the problem being considered steady in the first approximation. Some qualitative conclusions are made. The paper contains typographical errors.

Sh. A. Musaelyan

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4240. Vorontsov, P. A., Profiles of the basic meteorological elements in the boundary layer of the atmosphere (in Russian), *Trudi Gl. Geofiz. Observ.* no. 63(125), 55–76, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12894.

Paper contains the data derived from the results of aerostatic soundings (667 ascents) in the lower 500-m layer of the atmosphere. Soundings were only made in the daylight hours of each

24-hr period in anti-cyclone types of weather (clear skies in the surrounding area, visibility not less than 4 km, wind velocity not exceeding 12 mps.). The material obtained was classified according to the four seasons of the year and into four groups of values of the stability parameter $\Delta t/v^2$, where Δt is the difference in temperatures at levels of 1.5 and 100 m, v the wind velocity at 100-m level (group values of $\Delta t/v^2$ corresponded to intervals of $-\infty, -0.020, 0.020, 0.060, +\infty$). For these 16 groups, mean profiles were given for the temperature, potential temperature, relative humidity and wind force. The temperature and humidity profiles were approximated to the power formula of the form $A + Bz^n$. The wind profile in the layer 1.5 – 50 m was approximated to the logarithmic formula of the form $v_1 \lg(z/z_1)$; in the layer 25–150 m, to the generalized power principle of Lachtman; and in the layer 25–550 m, to the power principle of the form $v_1(z/z_1)^m$.

A. S. Monin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4241. Zavarina, M. V., Temperature and humidity changes of the air during its transformation into slow-moving anticyclones above the European territories of the USSR (in Russian), *Turdi Gl. Geofiz. Observ.* no. 55, 51–58, 1955; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12899.

Transformation of slow-moving air is investigated for all seasons of the year. When examining these transformations, computations were made for the temperature changes from day to day in the air and for the elasticity of the aqueous vapor for predetermined points, the links were sought between temperature changes of the air and the amplitude of the radiation balance of the underlying surface. Questions were touched on regarding the relation of the changes of air temperature to its humidity content. As the result of the analysis of the data obtained, a numerical appraisal is given regarding temperature and humidity changes of the air in the slow-moving anticyclones for the separate regions of the European territories of the SSSR.

G. V. Dmitrieva

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4242. Ogura, Y., On the truncation error which arises from the use of finite differences in the Laplacian operator, *J. Meteor.* **15,** 5, 475–480, Oct. 1958.

This paper derives a formula for reducing the systematic truncation error in the usual finite difference approximation to the Laplacian operator. However, it is important to realize that this formula has been derived with a particular problem in mind, that of dynamic meteorology where one is concerned primarily with small wave numbers. Although the derived formula is useful it is of no advantage when one is trying to evaluate the Laplacian operator irrespective of wave number. It is not clear how the method could be extended to cope with the general case, but this is an important paper in the restricted field to which it applies.

F. H. Bushby, England

4243. Fleagle, R. G., On the mechanism of large-scale vertical motion, *J. Meteor.* **15,** 3, 249–258, June 1958.

An equation is derived from the linearized equations of planetary aerodynamics which expresses the vertical component of velocity as a function of baroclinity, static stability, geostrophic vorticity, and geostrophic wind speed toward the north. The properties of this equation are compared with those of other equations and it is concluded that the linear equation provides an insight into the mechanism of large-scale vertical motion and that it is simple enough for easy application to real data.

Calculations of vertical velocity using the linear theory are compared with calculations using the adiabatic method, with calculations using two nonlinear methods, and with cloudiness and precipitations. The linear theory yields results which are relatively insensitive to errors in observation and analysis, and which compare favorably with results calculated from other methods. On the other hand, it is not notably more accurate than are other methods; all introduce errors which are comparable to the calculated values.

From author's summary by F. Bates, USA

4244. Kozharin, V. S., The role of turbulence exchange in the formation of spatial and external structures of clouds of layer formation (in Russian), *Meteorol. i Gidrologiya* no. 2, 3–9, 1957; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12896.

An evaluation was made of the turbulent energy level in different layers of the atmosphere in accordance with data obtained in soundings in the Leningrad region (1951–1954), Moscow (1951–1955) and Minsk (1951–1955) of temperature, wind, and air flight conditions. As an indicator of the degree of turbulence the Richardson (Ri) parameter was computed. The mean value of parameter Ri with cloudiness St-Sc (Ac), and also thin Ns-As showed that the layers below the clouds and in the clouds are characterized by a high degree of turbulence; in layers above the clouds the values of *Ri* are large. In the presence of strong cloudiness of the Ns-As type, and also when there is multilayer cloudiness, observations were carried out on the separation of the atmosphere into layers with varying degrees of turbulence. Each layer of cloudiness is located in the upper part of the turbulent layer. The lower boundary of the clouds is determined with the aid of the expression for the distribution of humidity in the turbulent medium in the absence of advection on the assumption that with the efflux of time a levelling off process takes place in the specific humidity contents in the agitated layer. Arising from the same assumption, that in its steady condition a levelling of the specific humidity takes place in the turbulent-agitated layer below the clouds, while in the cloud layer there is the maximum degree of specific humidity and aqueous content, it is feasible to deduce formulas for water content W and gradient of water content dW/dz. The dependence established of the relation of the gradient of water content to the gradient of temperature on the mean temperature in the clouds St-Sc agrees with the experimental data.

K. G. Abramovich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4245. Vorontsov, P. A., Dependence of the structure of an airflow on atmospheric conditions (in Russian), *Trudi Gl. Geofiz. Observ.* no. 63(125), 103–121, 1956; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12892.

Results are reported of the scrutiny of the data on the structure of the air field in the lower 300-m air layer; these were obtained by the author by using a specially designed and constructed apparatus for recording the mean wind velocity on a tied aerostat, which also recorded the horizontal and vertical velocity components. The measurements were carried out at levels of 3, 100, 200 and 300 m above the spread surfaces of four types (semi-desert, irrigated oasis, section of the water surface of a fiord, slightly sanded up locality in the N.W. European territory of the SSSR). The materials were grouped according to three types of thermal stratification of the air (unstable, feebly stable, inversion). According to these observational data calculations were made for the mean wind velocity v, for the amplitudes of the horizontal and vertical components of velocity Δv_i and w_i' and of their mean values, pulsation periods and of different derivatives of the characteristics. It was established that Δv increases with the increase of v, of the gradient of temperature γ, and of the gradient of wind velocity β, while w' increases with the increase of γ and v up to 5–7 m/sec, but with large values for v decreases (with w' inversions close to nought). The relative discontinuity $(\Delta v)/v$ and the wind inclination w/v increase with the increase of

y and diminish with the increase of v, and also ordinarily decrease with height. The pulsation periods grow with the growth of v and diminish with the growth of y. The values Δv_{max}, Δv_{min} are in good correlation with v; and the values of w'_{max}, with w, when in conformity with the line of regression

$$\frac{\Delta v_{max}}{\Delta v} = \frac{w'_{max}}{w} = 2, \frac{\Delta v_{min}}{\Delta v} = \frac{1}{2}$$

The transition from the weakly turbulent region to developed turbulence was observed in the 2-100-m layer at Richardson number values from 0.2 to 0.3, and in the 100-300-m layer, from 0.5-1.0.

A. S. Monin

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4246. Pinus, N. Z., The evaluation of atmospheric turbulence by means of the extent of swaying in high speed aeroplanes (in Russian), *Meteorol. i Gidrologiya* no. 10, 33-37, 1956; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11410.

Emphasis is laid on the fact that the intensity of bumping in an airplane in flight through turbulent atmospheric layers, as also the frequency of alteration of the signs of overloading, depends largely on the flight speed. Curves are given showing that overloads increase approximately by 0.08g with a velocity increase of 100 km/hr. The proposal is made that when computations for bumping are being carried out, the speed of the airplane should be conditioned by a certain figure, for instance, 500 km/hr.

L. A. Dikii

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

4247. Zubyan, G. D., The planetary frontal zone in the stratosphere (in Russian), *Meteorol. i Gidrologiya* no. 9, 12-21, 1956; *Ref. Zh. Mekh.* no. 8, 1957, Rev. 9149.

Data are presented on the connection between frontal zones in the troposphere and the lower stratosphere, respectively. Combined analysis is used of the qualitative character of the temperature fields on the isobarometric levels of 500, 300, 200, and 100 mb, in 33 vertical sections, for all morning periods of May 1955. Comparing the charts of the isothermals for the 500 and 200 mb levels, author underlines the presence of common singularities in the temperature distribution in the troposphere and lower stratosphere, respectively. With the same purpose, curves are plotted for these levels of the distribution of the horizontal temperature differences along a circle at latitude 55°, for each day of the period considered.

Author also presents a vertical section of the atmosphere intersecting the planetary, frontal zone in altitude, several times along the normal. It is pointed out that this section gives a picture of the penetration of frontal zones into the upper layers of the tropopause and the lower stratosphere, resembling that already found by Berggren [*Arkiv. Geofys.* **2**, no. 2, 1953] from analysis of a number of vertical sections.

K. G. Abramovich

Courtesy Referativnyi Zhurnal, USSR
Translation, courtesy Ministry of Supply, England

Naval Architecture and Marine Engineering

(See also Rev. 4140)

4248. Ogilvie, T. F., The theoretical prediction of the longitudinal motions of hydrofoil craft, *David W. Taylor Mod. Basin Rep.* 1138, 53 pp., Nov. 1958.

Author states that his modification of existing theory results in realistic predictions for the most important group of experiments reported on dynamic response of hydrofoil craft in waves. Author modifies Weinblum's theory and compares the results of analog computations of responses based on nonlinear equations with the experimental results of Leehey and Steele. The results show that the nonlinearities have only slight effect on the oscillatory amplitudes, but that they cause large steady components of heave and of pitch. The effects of nonsteadiness and also transient phenomena are investigated. A comparison with existing (but apparently meager) experimental data shows that the theory gives good predictions of the amplitudes of heave and probably of pitch, and fair predictions of phase.

T. P. Torda, USA

4249. Crewe, P. R., The hydrofoil boat; its history and future prospects, *Quart. Trans. Instn. Nav. Arch.* **100**, 4, 329-373, Oct. 1958.

The history of hydrofoil boats is traced from the earliest days of their development, and the main systems that have been invented are considered in their original and present-day versions. The advantages of this type of craft, compared with high-speed planing boats, are described. These comprise in particular lower resistance and better and more comfortable behavior in rough water.

It is argued that serious application of the hydrofoil principle had to await the development of analogous design concepts in the field of aeronautics, and of suitable structural methods and materials. The ground work necessary for the successful design and construction of passenger ferries carrying up to 70 people was not available until the 1940's, and even so the aftermath of the war delayed practical achievement until the early 1950's.

The problems of designing such ferries, work boats, sports boats and so forth of up to, say, 50 tons displacement, and having cruising speeds of around 40 knots, are now considered to be solved. These craft can operate satisfactorily in comparatively rough seas (e.g., up to 6-ft waves, depending on boat size) and also at high speed on inland waterways. It is expected that many such vessels will be built and will give excellent service in the next few years, and that the present rather limited disposable load (a fuel and payload together of about 25 per cent of all-up weight) will be improved. This improvement will come in part from a decrease in percentage structure weight arising from further developments in the techniques of constructing the hydrofoils.

It is shown that an outstandingly new field of marine craft performance is open to any vessel that can travel at, say, 70 knots, with a lift-to-drag ratio of 15 and a propulsive efficiency of 65 per cent. Special purpose designs using hydrofoils and having speeds of at least 60 knots are possible now, but disposable load is small. Serious consideration of hydrofoil craft designs capable of speeds in the 50 to 100 knot range awaits the development of efficient practical supercavitated hydrofoils.

Descriptions are given of the major detailed design considerations that determine the hydrofoil configurations. They are in particular, cavitation, static and dynamic stability, and structural requirements.

Some model tests made by Saunders-Roe, in connection with the Canadian *Bras d'Or* research hydrofoil boat, are discussed.

From author's summary

4250. Kom, F., Computation of the characteristics and stability condition of tunnel tail-shaped boats (in Hungarian), *Jarmuvek Mezogazdasagi Gepek* **5**, 5/6, 186-190, 1958.

Author discusses load-carrying capability and stability of ships with tunneled aft ends. These tunnels serve to increase the propulsive efficiency of shallow water multipropellered ships. In calculating both the load-carrying capacity and also the stability of such ships, three cases have to be considered. The first case is when the tunnel is filled with water; this con-

dition is achieved after a few seconds of starting the engines. The second case considered is when the tunnel is filled with air due to connection of the tunnel with the atmosphere. Finally, the intermediate case is where the tunnel is partially filled with water. Author states as conclusion of his analyses that the initial stability derivatives are considerably increased in the tunneled aft-end ships. T. P. Torda, USA

4251. Kinai, B., Vibration of an infinite plate floating on the surface of water (in Japanese), *Trans. Japan Soc. Civ. Engrs.* no. 54, 64-68, Feb. 1958.

Author deduces general formulas for the deflections of an infinite plate floating on the surface of water and bearing fluctuating loads which move with a variable speed on the plate.

From author's summary

Courtesy, Editorial Committee of the Japan Society of Civil Engineering

Friction, Lubrication and Wear

(See also Revs. 3722, 3793, 4055)

4252. Konstantinov, N. I., and Dragnysh, G. L., Problem of measuring surface friction stresses (in Russian), *Trudf Leningr. Politekhn. In-ta* no. 176, 191-200, 1955; *Ref. Zh. Mekh.* no. 10, 1957, Rev. 11845.

Paper records the investigation on pneumatic methods of measuring surface friction stresses. On the basis of Dean's theoretical solution for the slow movement of a viscous liquid near a plate, protruding into the flow normal to the surface flowed around, authors have worked out a new pneumatic method for measuring friction stress. The measuring device, which the authors have conditionally named "corner", is founded on the measurement of the fall of pressure at points lying in front of and behind the projection. Theoretically the relation was established between this fall Δp and the local stress of friction τ on the surface. The experiments were carried out in a transonic aerodynamic tube at velocities of from 10 to 30 m/sec. A comparison was made between the proposed method of measurement of the friction stress and the existing method of measurement, using a surface tube. As the result of the comparison it was established that: (1) the "corner" has a constant calibrated coefficient $k = \Delta p/\tau$ in the whole of the investigated range of flow velocities; (2) there is a theoretically unforetold increasing dependence of k on the height of projection d; (3) the calculated value of 2.90 agrees well with the value k z 2.6, the latter being obtained by extrapolation on the zero value of d and also by direct measurement with $d = 0$; (4) for the surface tubes the calibrated coefficient k depends substantially on the height of the receiving orifice of tube d; (5) at all values for d, the magnitude of k is strongly dependent on the magnitude of friction stress τ; (6) the value k = constant only holds good at small values for τ and when extrapolating on $d = 0$. k obtained in this way is equal to 2.2, while the theoretical value is equal to 1.67. A sharp difference in and conduct of the calibrating coefficients of the surface tube and "corner" is explained by the authors by the large disturbances produced in the flow when measuring with the surface tube, as the maximum height of the "corner" was equal to 0.04 mm, while the minimum height of the surface tube was equal to 0.06 mm.

V. N. Kalashnik

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

4253. Pavelescu, D., and Iliuc, I., Radioactive methods for determining the influences of viscosity upon the lubricant film thickness (in English), *Acad. Repub. Pop. Romine, Rev. Mecan. Appl.* **3**, 3, 299-312, 1958.

After reviewing the methods used so far for determining the lubricant film thickness and the data given by various investigators for the minimum film thickness below which the hydrodynamic lubrication no longer takes place, authors try to determine this minimum value through radioactive experimental methods. Case is chosen of two parallel circular plates which approach or separate each other under a given load. The film thickness-time dependence is deduced on the basis of the classical theory of hydrodynamic lubrication. An original radioactive method for measuring the film thickness is then presented, which consists in introducing a radioactive tracer into the lubricant and in measuring the film activity with a G.M. counter.

Conclusions include details on the accuracy of results and on the minimum film thickness required for hydrodynamic lubrication (about 0.8μ for the particular conditions under which authors' test was carried out). Various intervening factors are also discussed, i.e., surface roughness, lubricant viscosity, oil chemical composition, electrochemical superficial forces, and so on. V. N. Constantinescu, Roumania

4254. Fuks, G. I., Lubricating capacity of oils for apparatus lubrication (in Russian), Chasovye Mekhanizmy, Sb. 1 Moscow, Mashgiz, 1955, 186-215; *Ref. Zh. Mekh.* no. 11, 1957, Rev. 12792.

Author concludes that the lubricating power is determined by the interaction of the molecules of the liquid with the surface of the solid body, by the capacity of the films of the liquid to withstand high normal loads and show little resistance to tangential shear. Consequently the lubricating power should be evaluated by means of two values: the resistance of a thin film of the liquid to normal and to tangential stresses or the relation of the first value to the second. This relation is equal to 1 in the space occupied by the liquid and it only commences to increase in the boundary layers of the liquid. In order to study the mechanical properties of the boundary layers of the liquid, four methods were developed. One of these methods is based on the use of a variant of a four-ball apparatus for measuring friction. Three other sets of apparatus were adapted for the investigation of the static and kinetic conditions of adhesion. One of the methods used enabled the determination at one and the same time of the clearance between the contacting surfaces and the force of resistance of thin films of the liquid to normal loads. The investigation showed that the coefficient of friction of the oiled steel surfaces depends on the load; thus the friction principle of Coulomb-Amanton is not applicable to such systems. Their properties, with sufficient accuracy, are characterized by the two-term principle of friction by Deryagin. Investigation of the kinetics of adhesion of plane-parallel disks in oils showed that the thin films of oil in the clearances between the metallic surfaces can be classified according to their mechanical properties into three categories: (1) the plastic-viscous, adhering to the metal, (2) the film with a higher viscosity in comparison with the volumetric viscosity, (3) the film with a viscosity indistinguishable from the volumetric viscosity. The first and second films make up the boundary layer of the oil, the thickness of which in the case of the oils investigated did not exceed 0.40 μK.

It was shown that the lubricating power of an oil depends on its composition. In fatty oils it was higher than in mineral oils. The lubricating power of a mixture of the two had no additive effect. Addition of fats and more especially of fatty acids and other surface-active substances to mineral oils reduces the tangential and increases the normal component of the lubricating capacity of the oils, while the effectiveness of these additions still depends to a very large degree on the material composing the friction surface vapor and on the composition of the oils.

B. D. Zaloga

Courtesy Referativnyi Zhurnal, USSR

Translation, courtesy Ministry of Supply, England

4255. Halton, J. H., Lubrication of plain bearing—applicability of Reynolds hydrodynamic theory, *Engineering* **186,** 4818, 59-60, July 1958.

This article is a digest of a previous paper by the author, entitled "The lubrication of plain bearings: an examination of Reynolds's hydrodynamic theory." A set of assumptions is listed. With these assumptions as a basis, a generalized Reynolds equation and a corresponding energy equation are derived. Tests show that sometimes the generalized Reynolds theory is not applicable, because some of the assumptions on which the theory is based are violated. The violated assumptions are pointed out.

C. S. Yih, USA

4256. Pinkus, O., Analysis and characteristics of the three-lobe bearing, *Trans. ASME* **81** D (*J. Basic Engng.*), no. 1, 49-55, Mar. 1959.

Solution of 3-lobe journal bearing based on Reynolds equation is obtained on a 650 IBM computer. Expressions for eccentricity, lubricant flow, power loss are given for a range of length/diameter ratios and ellipticities (defined as distance between geometric center of bearing and center of lobe). It is also shown that this bearing is an effective design primarily for low load application where oil whip is the main concern.

C. F. Kettleborough, New Zealand

4257. Sternlicht, B., Elastic and damping properties of cylindrical journal bearings, ASME-ASLE Lubrication Conf., Los Angeles, Calif, Oct. 1958. Pap. 58-Lub-3, 7 pp.

The two-dimensional Reynolds equation including squeeze-film velocity is solved on a digital computer, using a finite difference technique for a cylindrical journal bearing under isothermal conditions. From the hydrodynamic forces so found, effective stiffness and dissipation of the system are calculated. The results may be used to study the dynamic stability of the bearing.

E. Saibel, USA

4258. Constantinescu, V. N., Turbulent lubrication of bearings under variable forces and velocities (in Roumanian), *Studii Si Cercetari Mecan. Appl.* **9,** 3, 657-677, 1958.

Paper concerns the turbulent flow within the lubricant film under unsteady conditions. By using Reynolds equation and Prandtl mixing-length theory, author obtains the lubrication equations in a form similar to that for a steady regime, due to the specific approximations of the lubrication theory, especially the neglect of inertia forces. The influence of the unsteady regime is introduced through the continuity equation.

Solution of the pressure equation is given by superimposing the following two solutions: a solution corresponding to that of the steady regime and a second one which depends on two arbitrary constants, function of time. Explicit results for slider and journal bearings are obtained.

Finally, the case of a journal bearing under a constant centrifugal load is discussed.

St. N. Savulescu, Roumania

4259. Constantinescu, V. N., Motion stability of journal bearings in turbulent regime (in Roumanian), *Studii Si Cercetari Mecan. Appl.* **9,** 4, 997-1012, 1958.

Author considers the motion equations of the two lubricated bodies, and uses a small perturbation method with respect to the main parameters which affect the problem. The Routh-Hurwitz classical stability criterion leads to a differential equation of the fourth order for the frequency ν, when the bearing bush is assumed to be at rest.

Both centrifugal and static loads are discussed, pointing out the Reynolds number influence on the stability conditions. Diagrams showing the dependence of the motion main parameters on the eccentricity ratio and on the Reynolds' number are presented. Author concludes that the instability range increases with the increase of Reynolds number, which fact is in agreement with M. I. Smith and D. D. Fuller's experiments.

St. N. Savulescu, Roumania

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CONTENTS

I. THEORETICAL ESTIMATION OF TRANSPORT PROPERTIES

Relations Between Molecular Absorptivities and Emissivities
Theories of Gas Transport Phenomena
Review of Modern Theory of the Thermal Conductivity of Metals

II. REVIEW OF RECENT WORK ON TRANSPORT PROPERTIES

Survey of Recent Work on the Viscosity, Thermal Conductivity, and Diffusion of Gases and Gas Mixtures
Review of Available Experimental Data on the Viscosity of Steam
Systems and Procedures Developed for the Search, Coding, and Mechanized Processing of Bibliographic Information on Thermophysical Properties
Transport Properties of Multicomponent Gas Mixtures at High Temperatures

III. THERMODYNAMIC PROPERTIES: GASES AND LIQUIDS

Thermodynamic Properties of Methane-Nitrogen Mixtures
Correlations and Equations Used in Calculating the Thermodynamic Properties of Freon Refrigerants
The Unmixing of Metal Solutions by a Temperature Gradient
Thermodynamic and Electrical Properties of Nitrogen at High Temperatures
Isentropic Checking of Vapor Tables at Saturation Boundary Lines and Ways of Improving Them

IV. PVT DATA AND EQUATION OF STATE

The Liquid Pressure-Volume-Temperature Relationships, Dew and Bubble Point Pressures, and Densities of a Binary Mixture Containing 75 Wt. % Freon-12 and 25 Wt. % Freon-22
Vapor-Liquid Phase Equilibria in the Binary Systems of Methane, Ethane, and Nitrogen
Application of the B-W-R Equation to Hydrocarbon-Carbon Dioxide Mixtures
An Equation for the Critical Isotherm of Gases
The Virial Equation Applied to Steam

V. THERMODYNAMIC PROPERTIES OF BORON COMPOUNDS

Characterization of Unusual Gaseous Oxide and Hydroxide Molecules in M-O-H Systems at High Temperatures
Thermochemistry and Thermodynamic Functions of Some Boron Compounds
The Combustion of Boron Hydrides
A Generalized Data-Fitting Routine for the LGP-30 Computer; Application to Real-Gas Properties of Diborane
The Low Temperature Thermal and Chemical Thermodynamic Properties of Boron Compounds

VI. TRANSPORT PROPERTIES: EXPERIMENTAL

Thermal Conductivity of Some Epoxy Plastics
Measurements of the Thermal Conductivity of Milk
Thermal Conductivity of Helium-Air Mixtures
Thermal Conductivity of Liquid Ozone
Thermal Diffusivity of Nitrogen as Determined by the Cyclic Heat-Transfer Method

VII. TRANSPORT PROPERTIES: EXPERIMENTAL

Experiments in the Molecular Diffusion of Gases at High Temperatures
The Effect of Moderate Pressures on the Viscosity of Five Gases
The Viscosity of Steam
The Viscosity of Steam-Nitrogen Mixtures at Atmospheric Pressure and Elevated Temperatures
Fluid Thermal Conductivity by a Transient Method
Thermodynamic and Transport Properties of Gaseous Carbon Dioxide

VIII. HIGH TEMPERATURE TRANSPORT PROPERTIES OF METALS AND CERAMICS

Thermal Expansion Coefficients of Binary Substitutional Solid Solution Alloys
Thermal Diffusivity of Metals at Elevated Temperatures
Thermal Conductivity of Aircraft Structural and Reactor Materials
The Total Emissivity of Aircraft Construction Materials
Specific Heat of Materials

IX. HIGH TEMPERATURE THERMODYNAMIC PROPERTIES OF GASES

Mechanized Computation of Thermodynamic Tables at the National Bureau of Standards: The Calculation of the Equilibrium Composition and Thermodynamic Properties of Dissociated and Ionized Gaseous Systems
Equilibria in C + H_2 and C + $2H_2$ Systems at Temperatures Between 1000 K and 6000 K
Equilibria in a Thermal Plasma Composed of C + H_2 and C + $2H_2$ in a Temperature Range From 5000 K to 50,000 K at a Total Pressure of 1 Bar
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INDEX OF AUTHORS REFERRED TO IN THIS ISSUE

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Aas-Jakobsen, A. 3815
Acrivos, A. 4110
Adams, M. C. 4101
Adamson, D. 4070
Akai, K. 4196
Akroyd, T. N. W. 3866
Albright, L. F. 4135
Aleksandryan, V. V. 4219
Alekseev, A. S. 3859
Altmeyer, G. 3882
Alumyae, N. A. 3821
Ambartsumian, S. A. ...3819
Anderson, F. E., Jr. 3864
Anderson, G. E. 4118
Anikin, E. P. 3780
Aoyagi, K. 4065
Apelt, C. J. 3973
Appleton, J. P. 4017
Argyris, J. H. 3928
Atkins, G. T. 4126
Atsumi, A. 3779
Axelson, J. A. 3982
Baikov, V. T. 3814
Bakondi, J. 3801
Bandettini, A. 4009
Bardoczy, L. 3874
Barducci, I. 3830
Barkhatov, A. N. . .4173, 4179
Baron, M. L. 4181
Barov, L. I. 4225
Bartenev, G. M. 3915
Bartholomew, E. R. 3917
Bassali, W. A. ...3805, 3808
Batchelor, G. K. 4119
Baulknight, C. W. 4086
Baum, V. A. 4113
Belkin, V. P. 3791
Bell, W. D. 3770
Beranek, L. L. 4183
Beresnev, B. I. 3880
Berger, W. J. 4169
Berman, L. D. 4125
Bernatowicz, D. T. 4150
Beutler, F. J. 4056
Biermann, A. E. 4046
Bijlaard, P. P. 3784
Bingen, R. 3767
Blackwell, B. D. 4032
Bleviss, Z. O. 4153
Boatright, W. B. 4070
Boisseau, P. C. 4024
Boldinskii, G. I. 3727
Bolt, B. A. 3724
Bomelburg, H. J. 4060
Bonchovskaya, T. V. 4233
Borbely, G. 3841
Bottema, O. 3725
Bouwman, H. B. 4187
Bowman, C. C. 3710
Bozhko, D. F. 4137
Bozsony, D. 3958
Brearley, M. N. 3724
Brendel, K. 3849
Brennan, J. N. ...3846, 3847
Bride, W. L. 3903
Bronskii, A. P. 3778
Brooks, G. W. 4042
Brooks, W. A., Jr. 3785
Brown, A. F. C. 3898
Brown, C. S. 3911
Bryant, L. 3981
Budagovskii, A. I. 4227
Budiansky, B. 3795
Budnick, G. 3883
Bueltman, C. G. 3766
Buhler, H. 3882
Burley, R. R. 3981
Burov, V. A. 4195
Burton, J. 4047
Cahn, M. S. 3983
Carjuzaa, C. R. 4117
Carlson, H. W. 4191
Carnegie, W. 3851
Carter, E. C. 4072
Castles, W., Jr. 4020
Cess, R. D. 4102
Chankvetadze, G. G. ...4218
Chaplygin, E. N. 4035
Chapman, J. C. 3905
Charwat, A. F. 3995
Cherkasov, B. A. 4037
Chernov, Yu. V. 3953
Cheverton, J. S. 3762
Childs, E. C. 3960
Chubachi, T. 3829
Cima, R. M. 4128
Claydon, D. G. W. 3908
Clevenson, S. A. 4162
Clutterbuck, Margery ...3983
Coburn, N. 4007
Cohen, E. S. 4124
Cole, A. G. 3898
Collar, A. R. 4018
Collis, D. C. 4103, 4108
Condon, E. U. 3707
Congleton, J. 3906
Constantinescu, V. N. 4258
4259
Conte, S. D. 3717
Cooney, J. D. 3753
Cooper, M. 4099
Crawford, D. H. 4074
Creer, B. Y. 3748, 4027
Crewe, P. R. 4249
Dames, R. T. 3717
Dancik, P. J. 4083
Danilov, V. L. 4220
Davies, H. J. 4017
Davids, N. 3855
Davison, E. H. 4150
Defant, A. 4237
Defant, F. 4237
De Vries, D. A. ...4093, 4094
Dewey, G. F., Jr. 4004
Diakalov, A. N. 4001
Dini, D. 4145
Dmitriev, A. A. 4233
Doluhanov, K. 3931
Don, D. G. 3914
Douvillier, J. G., Jr. 3748
Dragnysh, G. L. 4252
Drinkwater, F. J., III ..4027
Dutcher, J. L. 3754
Dzyadzio, A. 4199
Eberlein, A. J. 4051
Eckert, E. R. G. 4104
Edmonds, P. D. 3834
Egorov, A. I. 4217
Eggleston, J. M. 4025
Ehlers, F. E. 4003
Eickner, H. W. 3937
Elias, E. 3933
El-Sisi, S. I. 4055
Emmons, H. W. 3979
Emmons, W. O. 4127
English, R. E. 4150
Ensrud, A. F. 3913
Entwistle, K. M. 3852
Ermilova, N. I. 3858
Ernst, D. 3720
Escande, L. 4016, 4236
Espanol, C. E. 4117
Evans, W. P. 3909
Etkin, B. 4188
Fabri, J. 3980, 3990
Fay, C. 4064
Fedorov, K. N. 4232
Fedunskii, O. S. 4113
Felps, N. O. 4126
Fel'zenbaum, A. I. 4230
Fettis, H. E. 3709
Fine, M. 4029
Finney, J. M. 3887
Fleagle, R. G. 4243
Fowles, G. R. 3914
Fraenkel, L. E. 4022
Francis, J. R. D. 3943
Fuks, G. I. 4254
Fuller, L. 4073
Funke, P., Jr. 3881
Gainer, T. G. 4066
Galustyan, S. B. 3832
Gebhardt, H. 4200
Gedeon, G. S. 4165
Geiger, J. 3840
Gent, A. N. 3918
Gershuni, G. Z. ..4154, 4155
Gibbs, R. M. 4184
Girifalco, L. A. 3910
Glass, I. I. 4079
Goldberg, S. 3713
Golinskii, B. L. 3963
Goodger, E. M. 4133
Goodman, T. R. ..4095, 4096
Goodwin, R. D. 4130
Gorbunov-Posadov, M. I. 3868
Graham, J. M. 3771
Grigorian, S. S. 4005
Grimes, H. H. 3910
Grishook, I. K. 3961
Gross, S. A. 4038
Grodzovskii, G. L. 3987, 4001
Grubskii, B. A. 3952
Gruning, G. 3820
Gubin, V. I. 4239
Guest, J. 3715
Gundersen, R. 3998
Gupta, A. S. 3941
Gurin, A. I. 3741
Guseinov, G. P. 4216
Haacker, J. F. 3982
Hacques, G. 3723
Halfhill, D. 3757
Hall, D. A. 4057
Hall, J. G. 4080
Halton, J. H. 4255
Hanamoto, B. 3867
Hanerus, L. 4132
Hanratty, T. J. 4112
Hansen, V. E. 3710
Harris, E. G. 4157
Hashikura, K. 3862
Hayday, A. A. 4116
Heckl, M. 4180
Heinen, R. 3806
Hewitt, Helen 4084
Hickey, D. H. 4065
Holfelder, O. 4138
Holzmuller, W. 3942
Hookway, D. C. 3940
Horvay, G. 3792
Hottel, H. C. 4124
Houghton, D. S. 3818
Howard, E. D. 3878
Howell, H. H. 4184
Hunter, P. A. 3992
Huppert, P. A. 3920
Huseby, R. A. 3938
Hussmann, A. W. 4076
Hyrbyk, B. D. 3768
Ianenko, N. N. 4002
Ifrim, M. 4223
Iliuc, I. 4253
Irapezin, I. I. 3814
Irvine, T. F., Jr. 4104
Isler, W. E. 4009
Ivanov, A. A. 4234
Ivanova, T. V. 3930
Ivanovskii, A. I. 4178
Ivicsics, L. 3949, 3950
Iwaki, A. 3793
Jackson, C. E. 4028
Jacobs, R. B. 3945
James, C. S. 4012
Jandy, G. 3877
Jenkins, D. P. 3739
Jenson, V. G. 3970
Jensen, W. R. 3824
Johns, D. J. 3786, 3825, 4161
Johnson, E. C. 3760
Johnson, H. A. 4097
Jones, E. E. 4019
Jones, R. A. 4010
Joyce, A. H. 4053
Kabel, R. L. 4112
Kadashevich, Iu. I. 3799
Kakutani, T. 4013, 4158
Kal'ner, D. A. 3803
Karev, V. N. 3966
Keck, G. 4194
Kellenberger, W. 3836
Kemp, N. H. 4151
Kenney, W. F. 4135
Kertz, W. 4238
Kezdi, A. 3869
Khaikovich, I. M. 4175
Khalas, O. 3923
Khalfin, L. A. 4175

INDEX OF AUTHORS REFERRED TO IN THIS ISSUE *(Continued)*

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Khamrui, S. R. ..3971, 3972
Kimura, K. 4202
Kinai, B. 4251
Kirillov, V. V. 4107
Kirsanov, M. V. 3965
Kirschnick, H. J. 3768
Kladnitsky, V. M. 3930
Klassen, V. I. 4211
Kleeman, P. W. 4106
Kleiman, Ia. Z. 4000
Klement, R. 3828
Kliushnikov, V. D. 3798
Kloeris, P. W. 3885
Kmosko, K. 3934
Kochanski, S. L. 3928
Kochina, N. N. 4172
Kogan, M. N. 3997
Kohl, R. C. 4046
Koizumi, I. 4141
Kolb, A. C. 4152
Kollar, L. 3865
Kom, F. 4250
Kompass, E. J. 3755
Kondrat, K. I. 4044, 4045
Konobeevskii, S. T. 4164
Kononkin, B. K. 3964
Konotorovich, V. M. 3999
Konstantinov, N. I. 4252
Korobeinikov, V. P. 4171
Kotenev, I. V. 4041
Koyasu, M. 4177
Kozharin, V. S. 4244
Kneschke, A. 3879
Knowles, J. K. 3817
Kraft, H. 4132
Kraichnan, R. H. 4190
Krasil'nikov, V. A. 4195
Krasnosel'skii, M. A. 3736
Kreith, F. 4090
Kraus, L. 3826
Kresser, W. 4235
Kruger, H. 4030
Krylov, Yu. M. 4229
Kryter, K. D. 4183
Kuchmin, O. I. 4192
Kuehn, D. M. 4011
Kuhn, W. 4201
Kumar, S. 3855
Kuriyama, H. 3862
Kutin, B. N. 3744
Kuz'min, P. I. 3745
Kuz'minov, M. P. 3872
Laikhtman, D. L. 4228
Lambe, C. G. 3708
Leadbetter, S. A. 4162
Leadon, B. M. 4118
Leavy, L. E. 4071
Lebedev, I. V. 4059
Lebedev, P. I. 4231
Leglise, A. 3767
Leitmann, G. 4168
Lengyel, P. 3801
Lenherr, F. E. 4039
Leonard, R. W. 3853
Levanovskii, L. B. 3955
Li, H. 4159
Lieblein, S. 4150
Lindley, P. B. 3918
Liu, S. W. 3719
Logan, J. G., Jr. 4121
London, A. L. 4128
Lopovok, B. N. 3814
Losaberidze, A. A. 3926
Losch, K. 3762
Loubser, R. S. 3888
Love, E. S. 3989
Lueg, W. 3881
Lukaszewicz, J. 3714
Lunev, V. V. 3994
Luthy, A. 3939
Lykova, O. B. 3735
McAlevy, R. F., III 4078
McCarty, J. L. 4042
McCauley, W. D. 4074
McEwan, A. D. 3887
McFarland, D. R. 4061
MacLean, W. R. 4185
Maglieri, D. J. ...4042, 4191
Magnus, K. 3750
Maikapar, G. I. 3988
Mains, R. M. 3848
Major, P. 3959
Mak, S. L. 3889
Maksimov, V. S. 4203
Malmeister, A. K. 3804
Mandelbrot, B. 3712
Mann, J. Y. 3887
Manolov, S. 3731
Markland, E. 3974
Martinek, J. 3838, 3946
Mar'yamova, F. A. 3831
Mason, W. P. 3902
Mathias, R. A. 3758
Matveev, K. V. 4226
Mayo, A. P. 4043
Mayo, E. E. 4099
Meissner, B. A. 3892
Mel'nikova, N. S. 4172
Melosh, R. J. 3927
Melyakhovetskii, A. S. ..3833
Mergler, H. W. 3759
Merrick, R. B. 4027
Merritt, R. G. 3927
Messing, W. E. 4147
Messiter, A. F. 3993
Meyer, E. 3849
Michelson, I. 4159
Mikhalovskii, V. A. 3728
Mikheev, M. A. 4113
Miller, E. V. 4211
Miller, L. N. 4183
Minina, O. M. 3742
Mirels, H. 4081
Mitropol'skii, Yu. O. 3737
Miyamoto, H. 3774
Mohr, W. 3962
Moiseev-Ol'khovskii, I. I. 4087
Molotkov, I. A. 3857
Monroe, D. E. ...4033, 4034
Moore, M. G. 3909
Moran, J. P. 3781
Mori, A. 3870
Mori, M. 3793
Morrell, G. 4100
Morris, G. R. 3734
Mortlock, A. J. 4089
Moskvichev, A. D. 4210
Murphy, H. L. 3863
Murphy, J. S. 4075, 4077
Murzewski, J. 3813
Naghdi, P. M. 3782
Narasimhamurthy, P. ..3797
Naugolnykh, K. A. 4176
Nazarov, A. G. 4224
Nazarov, G. I. 3975
Nelson, J. M. 3978
Nel'son-Skornyakov, F. B. 4207, 4208
Nesina, L. V. 4129
Nesterov, I. M. 4211
Neumark, S. 3738
Newcomb, T. P. 4091
Newton, R. R. 4166
Nikolaev, V. V. 4049
Nocilla, S. 3984, 3985
Novakovic, M. 4050
Novoselov, V. S. 3729
Novozhilov, S. Ya. 4040
Novozhilov, V. V. 3799
Nowinski, J. 3935
Obraztsov, I. F. 3929
Odishaw, H. 3707
Ogilvie, T. F. 4248
Ogura, Y. 4242
Ogurtsov, K. I. 3858
Ohara, S. 4197
Ohasi, Y. 3894
Oleinik, N. V. 3889
Olszak, W. 3800, 3813
Oman, R. A. 4114
Onoe, M. 3837
Ouvrier, E. 3922
Pajevic, M. 3921
Pakharev, N. O. 4214
Papoulis, A. 3732
Paria, G. 3775
Parkes, E. W. 3783
Parkins, R. N. 3906
Parshchik, S. A. 4144
Patraulea, N. N. 3977
Paulon, J. 3990
Pavelescu, D. 4253
Pavlikhina, M. A. 4163
Peck, A. J. 4093, 4094
Perlmutter, M. 4105
Persson, P.-O. 4132
Peterson, G. A. 3914
Petookhov, B. S. 4107
Petrick, M. 4063
Petrov, V. V. 3743
Petrovskii, A. V. 3835
Petschek, H. E. 4151
Phillips, W. H. 4025
Pichugin, D. F. 4143
Pilnick, C. 3773
Pinkus, O. 4256
Pinsker, W. J. G. 4026
Pinus, N. Z. 4246
Pisent, G. 3830
Piskunov, N. S. 4204
Plaksin, I. N. 4211
Polikovskii, V. I. 4143
Pogodin, Iu. Ia. 4002
Popov, I. G. 3925
Poppendiek, H. F. 4098
Potocki, F. P. 3904
Pound, T. N. 4068
Powell, A. 3884
Powell, J. W. 3765
Powers, J. E. 3978
Press, S. J. 4148
Probstein, R. F. 4101
Pronin, V. M. 3889
Pullman, W. A. 4076
Quinlan, P. M. ..3789, 3809, 3810
Rabinowicz, J. 4159
Raevskii, A. N. 3925
Ramanova, E. Ya. 4206
Rannie, D. 4077
Rasulov, M. L. 4213
Rathert, G. A., Jr. 3748
Rauch, L. L. 4056
Razov, I. A. 3891
Rebrov, G. F. 3956
Reid, J. 4073
Reimann, V. 3895
Reissner, E. 3817, 3845
Rekach, V. G. 3823
Riazanov, E. V. 4171
Ribner, H. S. 4188
Richmond, J. C. 4120
Ricupito, J. R. 4169
Riester, E. 4067
Rietdijk, J. A. 4131
Roberson, R. E. 4170
Rohlik, H. E. 4146
Roscoe, K. H. 3873
Rose, P. H. 4101
Rosen, E. M. 4112
Rosin, P. O. 4139
Roston, S. 3747
Rowley, G. C. 4085
Rozanova, V. I. 3915
Rozsa, L. 3875
Rubinstein, L. I. 4212
Ruff, K. E. 4053
Runckel, J. F. 4062
Rutkovskii, V. Iu. 3743
Ryabinin, Yu. N. 3880
Ryder, F. L. 3721
Ryhming, I. 4006
Sacca, D. B. 4127
Sahmel, P. 3924
Sakurai, H. 3862
Sanders, G. J. 4189
Saunders, O. A. 4134
Savet, P. H. 4088
Scala, S. M. 4086
Scheidegger, A. E. 4222
Scheuing, R. A. 4114
Schmieden, C. 3733
Schofield, A. N. 3873
Schumann, W. 3796
Schwieger, H. 3895
Scott, C. J. 4118
Scott, I. G. 3900, 3901

(Continued on outside back cover)

INDEX OF AUTHORS REFERRED TO IN THIS ISSUE *(Continued)*

(NUMBERS USED ARE SERIAL NUMBERS OF REVIEWS)

Seban, R. A. 4097
Seidel, B. S. 4031
Sekiguchi, H. 3919
Senior, D. A. 3897
Senoo, Y. 4031
Serebryanyi, R. V. 3811
Serpeninov, B. N. 3891
Shakhovkin, V. M. 4215
Shapovalov, L. A. 3827
Sharov, V. S. 3871
Sharp, J. F. 3772
Shawki, G. S. A. 4055
Shea, J. J. 4096
Shekter, O. J. 3876
Sheldon, J. W. 3716
Shen, S. F. 4160
Shestakov, V. M. 4205
Shevandin, E. M. 3891
Shima, S. 3947
Shinyglevskii, Yu. D. ...3991
Shirokov, M. F. 3996
Shmelev, I. I. 4173
Shoemaker, E. M. 4003
Shpol'skii, A. V. 4164
Sibulkin, M. 4008
Sidlyar, M. M. 3860
Siegel, R. 4105
Simon, A. W. 4122, 4123
Sinelschikov, S. I. 3868
Sirotin, Yu. I. 3788
Sittig, E. 3834
Skudrzyk, E. J. ..4174, 4186
4193
Slone, H. O. 4150
Smirnov, L. P. 4163
Smirnova, T. N. 3802
Soffa, L. 3885
Sokolowski, M. 3812
Speidel, L. 4015
Spink, L. K. 4048
Spotts, M. F. 3722
Squire, W. 4023
Stenning, A. H. 4031
Stepanov, N. G. 4209
Stephens, Emily W. 4082
Stepniewski, W. Z. 4083
Sternlicht, B. 4257
Stewart, J. D. 4027
Stewart, J. E. 4120
Stewart, R. M. 3749
Strakhovich, K. I. 3794
Strubell, W. 4115
Suchkov, V. R. 4002
Sugimoto, T. 3862
Summerfield, M. 4078
Sumner, G. 3852
Swainger, K. 3969
Swanson, B. S. 4063
Swihart, J. M. 4062
Szabo, J. 3932
Szesztay, K. 3948
Tamm, K. 3849
Tatsumi, T. 4013
Taylor, Sir Geoffrey ..3976
Teodorescu, P. P. 3776, 3787
Terminasov, Yu. S. 3802
Terskikh, V. P. ..3842, 3843
3844
Testerman, M. K. 3912
Tetel'baum, I. M. 3751
Thom, A. 3973
Thomas, T. Y. 3890
Thompson, K. R. 3764
Timofeef, M. P. 4228
Timson, G. W. 4077
Tipei, N. 4021
Tokarev, V. V. 4001
Tolstykh, A. I. 4001
Tominaga, M. 3947
Topchevskii, B. A. 3953
Toralballa, L. V. 4149
Trathen, W. J. 4052
Trilling, L. 4014
Tripp, R. H. 4084
Trofimenko, A. T. 4111
Trofimenkov, Yu. G. 4221
Tsepelev, N. V. 3859
Tsitovich, P. A. 3726
Tucker, K. F. 4072
Turnbull, D. E. 3746
Turner, P. E. 4069
Tuzov, A. P. 3740
Uspenskii, L. N. 3858
Utagawa, M. 3861
Vagas, I. 3951
Valstar, A. 4131
van Eepoel, P. 4054
Van Houten, G. R. 3936
Van Huben, L. 3769
Van Tuyl, A. 3986
Vasil'ev, A. P. 4136
Vasil'ev, D. M. 3907
Venkatasubramanian, V. S.
3944
Vereshchagin, L. F. 3880
Vertregt, M. 4167
Vid, V. E. 4058
Viktorov, I. A. 3856
Vinogradov, M. I. 3954, 3965
Vinokurov, E. F. 3777
Voitashevskii, D. A. 4036
Volk, W. 3711
Vol'mir, A. S. 3816
Vorob'ev, I. N. 4109
Vorob'ev, N. N. 3790
Vorontsov, P. A. ..4240, 4245
Voskresenskii, K. D. 4113
Vroman, J. 3767
Vulis, L. A. 4111
Waisman, J. L. 3885
Wakelin, R. J. 4092
Wallace, F. J. 4142
Warmus, M. 3714
Washizu, K. 3845
Wasow, W. 3718
Weeks, D. J. 4134
Weibel, E. S. 4156
Weidenhammer, F. 3850
Weis, O. 3896
Wells, J. D. 3807
Werren, F. 3916
Wherry, J. E. 4028
Wildanger, E. 3757
Williams, M. J. ..4103, 4108
Winget, J. L. 3761
Winter, K. G. 3911
Woolston, D. S. 4162
Wooster, W. A. 3763
Wong, R. Y. 4033, 4034
Wroth, C. P. 3873
Yarema, S. Ya. 3899
Yaroslavtsev, I. A. 3967
Yeh, G. C. K. 3838
Yen, C. S. 3885
Yih, C.-S. 3968
Yonezawa, H. 3854
Young, L. H. 3756
Yu, Y.-Y. 3839
Zababurin, I. A. 3957
Zabelina, E. I. 3730
Zavarina, M. V. 4241
Zel'tin, A. I. 3727
Zharmagambetov, B. S. 3822
Zhenishek, N. N. 4198
Zhukhovitskii, E. M. ...4154
4155
Zubyan, G. D. 4247
Zwetz, H. 3720
Zyl'ev, B. V. 3752